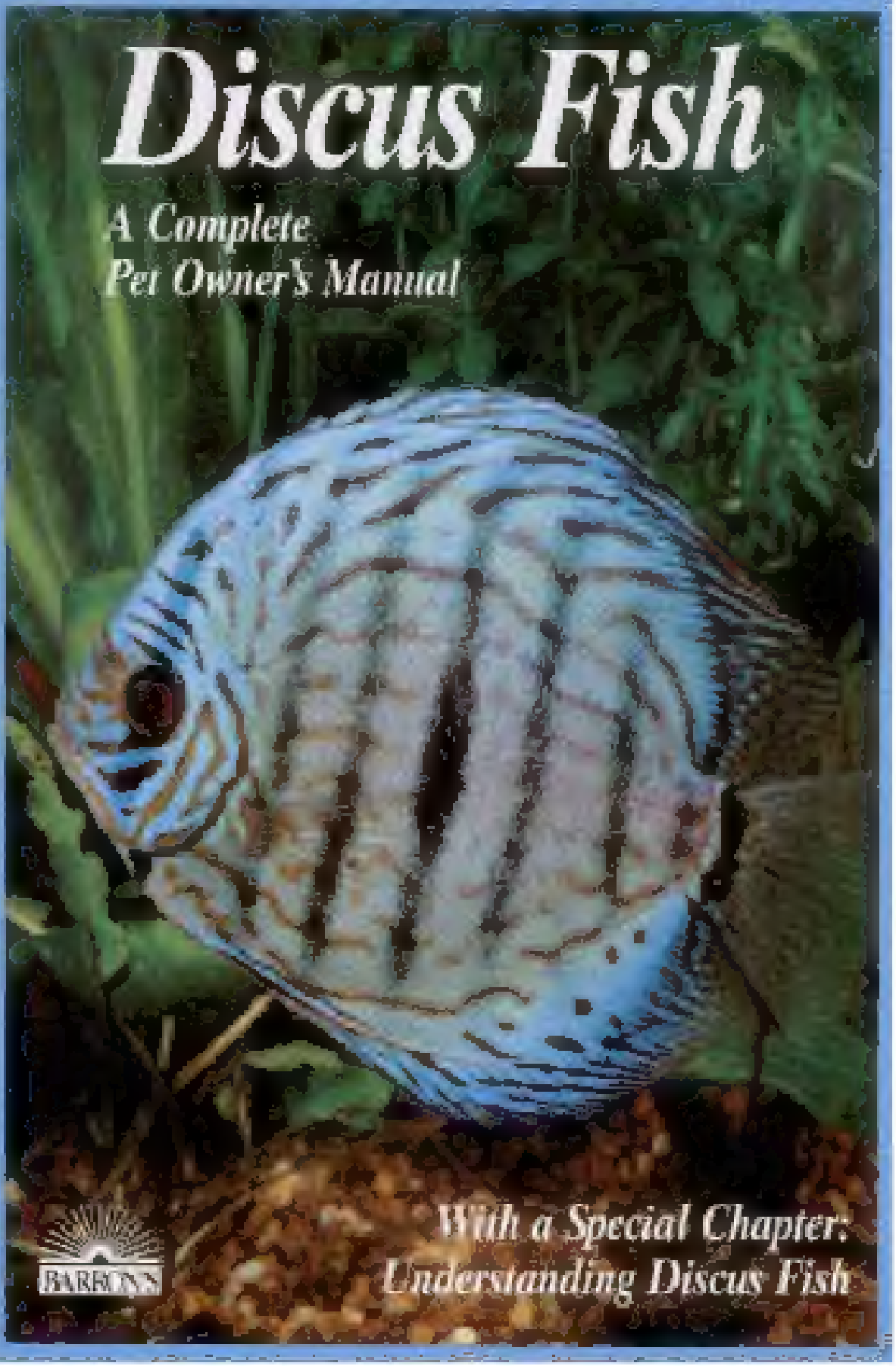
Discus Fish

A Complete Pet Owner's Manual



BARRON'S

With a Special Chapter: Understanding Discus Fish

Thomas A. Giovanetti

Discus Fish

Aquatic Consultant: David Schlesser
Aquatic Biologist, Dallas Aquarium

With 25 Color Photos
Illustrations by Michele Earle-Bridges

Consulting Editor: Matthew M. Vriends, PhD

BARRONS

About the Series

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Preface

Of the many fishes available for aquarium use, none has caught the fancy of aquarists quite like the discus. Though no other fish group, not even the colorful marines, inspires such appreciation and dedication in the fish keeping world, discus are not as difficult to keep reputation and many of their keepers might lead you to believe.

Success in keeping discus is promoted by studying the animal's natural habitat. Where in the fish found? What is the chemistry of the water? What climatic cycles occur there? What makes up the bulk of the fishes' diet? We need more extensive information on ecological parameters and attempt to approximate these conditions in our home aquaria. Though discus have been kept successfully for decades, technology today helps us to more closely simulate their shallow, the natural habitat of the discus. In fact, we can simulate discus so closely that the discus will spawn and raise their young with little human intervention.

People keep discus for a variety of reasons. For some, the color, shape, and regal bearing of discus are an overriding attraction. Who would not be entranced by the metallic green of a large turquoise or orange discus under proper light? Most discus keepers recall the initial awe at seeing dishes of spectacularly colored discus in tropical fish retailers or books. To a hobbyist who has become bored with traditional choices, the first glimpse of a colorful discus opens a new world.

Consider carefully whether discus are for you. Because they are more demanding of water quality than many other aquarium fish, discus require more water testing, more regular water changes, and more reliable filtration equipment than other fish do. A large aquarium is necessary, at least 18 inches (45 centimeters), and preferably no smaller than 30 gallons (113.5 L). Discus are not active swimmers like other cichlids. They tend to hover quietly behind and among the leaves of plants, and move about in a regal, dignified manner. They do not financially ruin around the aquarium, nor do they bore onlookers with fast, frantic feeding in one of the features that makes discus so attractive.

For some, discus keeping represents the highest level of the aquarist's craft, mainly because discus are among the most expensive aquarium fishes. This is because of the relative rarity of excellent specimens and the difficulties associated with breeding discus. One can often find small, juvenile discus at relatively moderate prices, but once discus grow up, they become more expensive, due mostly due to the retailer's risks. High quality discus, spawned and reared by one of but a handful of select breeders, are harder to find and are therefore more expensive.

Discus keeping also represents a challenge for the freshwater aquarist because of their aquatic difficulties. Care problems have been exaggerated to the point that many hobbyists never attempt to keep discus, and many retail clerks mislead prospective buyers for the same reason. While discus are demanding fish, anyone willing to study and meet their needs will be rewarded with success.

Why keep discus? Because they are among the most beautiful and interesting aquarium fishes, as you will see.

The author and the editors of Barron's Series of Nature Books wish you many enjoyment with your discus. The author would also like to thank all those who had a part in the production of this book, including Dr. Matthew Nemuth, Helen Dickes, Dr. Paul Loiselle, Aaron Norman, but particularly Dr. David Schlosser of the Dallas Aquarium, without whose expertise this volume would not have been possible.

Tom Gamarello
Summer, 1991

Understanding Discus

Classification and Popular Names of Naturally Occurring Forms

Discus were discovered in 1840 by the Viennese ichthyologist, Dr. Johann Jacob Heckel. The initial living specimens were shipped to Germany by sailing in barrels or 55-gallon (208 L) drums, and there were very heavy losses. It was not until the 1970s and 1980s that aquarium-fish dealers began importing discus into Europe and the United States under the common name "pompadour fish."

> Discus are fish which often are prized primarily for their beauty. Discus, angelfish (*Pterophyllum* spp.), and koi are the ornamental fishes (*Pisces*) we all think of when we think of fish. Discus are the most colorful fish commonly kept in all the hobbies, and they are beautiful, highly social fish that little resemble their cichlid relatives. Specific they are not aggressive, they must be kept with companions and will pick in their close shoal, and are subject to fast growth in prolonged, or they may be kept with other non-aggressive fish.

We will make a careful distinction between naturally occurring forms and tank-bred varieties. Naturally occurring discus, though subject to limited variability, will usually have a predominant color consistent with other specimens from the same area. Tank-bred varieties, however, may be widely divergent from the original wild stock. Most fish available in the trade today are tank-bred varieties.

Under the present classification, there are two genus of discus, six four types, at one of the three contains four subspecies. Whether the six are separate subspecies or simply morphotypes (geographical variations) is a subject of disagreement. The production of discus will be classified in the same species in the near future, but the classification scheme we use in this book is as follows:

> An amphibious fish is an animal which can live on land or in water. Discus are amphibious in appearance, but are distinguishable from others of the same genus by the very small size of their gills, and will use differences in physical appearance.

1. *Symphysodon discus*, or the Heckel discus
2. *Symphysodon aequifasciatus* sp., which contains:
   a. *Symphysodon aequifasciatus aequifasciatus*, or the green discus
   b. *Symphysodon aequifasciatus haraldi*, or the blue discus
   c. *Symphysodon aequifasciatus axelrodi*, or the brown discus

The first species is *Symphysodon discus*, or the Heckel discus, sometimes called the blue Heckel or red Heckel, and rarely still called the pompadour discus. Heckel discus are native to the Manaus (Rio Negro) region (Amazonas, Brazil). Of the four species of subspecies, the first, third, and fourth stripes are generally, with the fifth occasionally, more than the others. The first stripe runs through the eye, the fifth through the corner of the body, and the fourth through the base of the tail. Tank-bred varieties may be lacking present in Heckel discus. The first has a mahogany background color, with faint blue stripes running horizontally through the body and with fins edged in red.

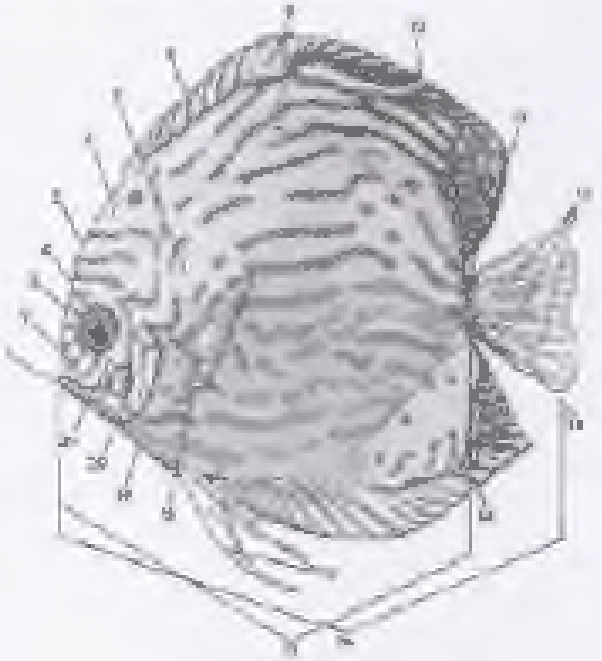
Heckel discus are the most sustainable type, in density because most hobbyists prefer the turquoise or brown varieties rather than the other types of discus, and because Heckel discus are more difficult to breed than other discus. Many breed varieties will more easily than females, as Heckel males are often mistaken for females of other species by the sale of their color and patterns, especially in Asia. The dark vertical stripes have proved very difficult

Understanding Discus

to breed out of the line. Typically, aquarists want color and black stripes, so the tank-bred Heckel discus are increasing. This is unfortunate, as there should be hobbyists who seek to preserve the naturally occurring forms. Because of the massive lack of interest in cultivating the pure Heckel strain, almost all Heckel discus available today are caught wild. Heckel discus come from slightly warmer water than do other discus, and this should be taken into account when keeping them.

Symphysodon aequifasciatus aequifasciatus, or the green discus, is the nominate subspecies of the normal discus group. Most green discus come from the Paramaribo area on the northern border of Brazil and are shipped out of either Leticia, Colombia, or Iquitos, Peru. Many Peruvian green discus shipped out of Iquitos are captured in the Rio Nanay, which flows into the Amazon at Iquitos. Green discus are highly variable in pattern and color. The normal green discus has a background color that varies from brown to greenish olive, with metallic horizontal stripes in the dorsal area and on the belly. These stripes extend into the dorsal and anal fins. The major portion of the body lacks these horizontal stripes, but red spots often are present on the sides. Green discus usually have more stripes than do brown discus. Strains of green discus having green stripes all over the body are often called jewel green discus, which are in great demand.

Another variant of the green discus that is also popular, but very rarely available, is the Tefé discus, named after the Brazilian town and lake of Tefé on the Solimões. Some believe that the Tefé discus is a natural intergrade between the brown-blue *Symphysodon aequifasciatus aequifasciatus* and the green discus. Tefé discus have a greenish-gold background, with many red spots all over the head, scales and fins and fins. Occasionally the red spots occur over the entire body, but always the first and last vertical stripes are horizontal.



Parts of a discus:

1. Mouth
2. Nostril
3. Swim bladder (open)
4. Eye (white)
5. Nape (horizontal)
6. Head
7. Belly
8. Spinous dorsal fin
9. Dorsal edge
10. Soft dorsal fin
11. Caudal peduncle
12. Caudal spines
13. Tail (caudal) fin
14. Anal fin
15. Pelvic fin
16. Total length
17. Standard length
18. Vertical fin
19. Tassel
20. Operculum (gill cover)
21. Interpelvic bar (cross)

Understanding Discus

The turquoise discus is the dominant strain on the market today. In the turquoise strain, the natural greenish stripes of the green discus have been reduced with a bluish color (possibly due to T. ocellatus influence), resulting in horizontal stripes that vary from bluish-green to greenish-blue. Some turquoise discus are almost entirely blue on the body, and these are often called cobalt turquoise discus. Within the turquoise strain there are dozens of separate strains, with names like "brilliant turquoise," "red turquoise," and the like. The abundance of color strains can be bewildering to the beginner. Turquoise discus are more expensive than browns, greens, or Heckels, but are usually much more aesthetically rewarding.

The turquoise *Symphysodon aequifasciatus aequifasciatus*, or the brown discus, comes from Brazil's Rio Negro, the mouth of the Amazon. The brown discus remains the most commonly kept discus in home aquariums, but it has recently been supplanted by the more colorful varieties. Brown discus range in color from light to dark brown and do not have the horizontal fifth vertical band as does the Heckel discus. Striations on the brown discus appear on the forehead and anterior dorsum, and through the head and fins. Some reddish specimens are occasionally found. Many of these reddish fish, unfortunately, do not continue strong coloration in captivity, but instead fade, presumably in their natural habitat. Some so-called "red" discus bred in the Far East have had their color heightened by being fed large quantities of the pigment Microlactin, a carotenoid pigment extracted from crustacean variations. The color intensifies in the normal manner only a few weeks after the fish have been selected from the vats. Discus has been bred for commercially desirable traits, most noticeably heightened by the orange coloring of the muscular tissue of their pectoral fins. On well-bred specimens, the eye, and the fin and tissue area.

The third subspecies of *Symphysodon* [illegible] *Symphysodon aequifasciatus haraldi*, the blue discus, from around Manaus. Blue discus rarely reproduce their coloration, the brown discus, and for this reason some feel that blue discus are finding more than simply colored brown discus. Unlike the brown discus, however, blue discus have a darker, almost purple-brown ground color, especially on the face. Blue horizontal stripes run across the head and dorsal and ventral areas. Blue discus with bright horizontal stripes throughout their bodies are called "royal blue discus," and the name is apt for really fine specimens. Too often, however, the name royal blue discus means little, for many blue discus are sold as royal blue because of the higher price they command. True royal blue discus are as fine a sight as you are likely to see in freshwater aquariums. There is another popular domestic strain of blue discus called cobalt blue or powder blue discus. Cobalt blue discus are entirely blue or almost so, with little or no striation of any type. Cobalt blue discus have a metallic sheen that is quite attractive. They do not exist in nature, however, and therefore should not be confused with the wild blue discus.

These are the basic discus types that the hobbyist is most likely to encounter. As mentioned earlier, you will see many other strains, as well as unusual mutations like albino discus, blue-faced discus, albino discus, and others. Until you develop some expertise at breeding discus, you would do best to stick with the mainstream types.

Are Discus Really Hard to Keep?

We spoke earlier of the reputation discus have for being hard to keep; we pointed out that it is not necessarily true. Discus are not so hard to maintain that you should be dissuaded from keeping them, but you cannot expect to be successful with discus by simply taking a few of them into a typical community aquarium. This is so for several reasons:

Discus Sensitivity

Discus are more susceptible to common aquarium pathogens than many typical community aquarium fish are. It is particularly tricky to keep

Understanding Discus

discus with angelfish and keyhole cichlids, though some beginning discus keepers find that they can do just that. Almost all angelfish in the aquarium hobby are bred in captivity and frequently carry internal parasites, diseases to which discus are more especially prone. Because of the discus' demonstrable sensitivity to parasites and disease to which other aquarium fish are more resistant, it is obvious that the safest way to keep your discus healthy is to keep them in a separate tank, an aquarium in which a single species of fish is kept. It is possible, however, to keep discus mixed with angelfish (*Pterophyllum* sp.) provided you are sure the angelfish are not carrying any disease organisms. Procedures for disinfecting such fish through quarantine and medication are discussed in the chapter, "Discus: Reception and Treatment."

Several other species of tropical fish make excellent tankmates for discus. A school of some small, peaceful, non-aggressive tetras, glassfish, rasboras or Cardinal tetras in a fish-only display with discus, particularly if you need the aquarium to be more or less of exhibit, will instead keep a school of fifteen or twenty of a single species. I am particularly partial to combining a school of pygmy tetras from the African Congo rivers with discus, though some people may prefer the safe intimacy of keeping only South American species together. A pair of dwarf cichlids (*Apistogramma cacatuoides*) also does well, as do Clown Loaches (*Botia macracantha*), though all of these fish should be quarantined and treated before being added to the discus aquarium. All these fish are very tolerant of the required water temperatures and conditions for discus. The chapter on the planted aquarium recommends a few other suitable fish that are useful for algae control in a discus tank.

If you choose to keep your discus in a community aquarium, however, it's wise to regard the aquarium primarily as a discus tank, with a few other species mixed in, rather than vice versa. Keeping your priorities clearly in mind will help you make proper decisions when difficulties such as disease and parasite infestations occur.

Water Temperature Requirements

Discus require higher water temperatures than most other tropical aquarium fish. This is obvious from what has been reported about the natural habitat of discus. If discus are kept at temperatures outside the range of normal aquarium fish—86°F (30°C)—they display a marked increase in disease susceptibility. For this reason, discus should be maintained between 82°F (28°C) and 86°F (30°C).

> Aquarium hobbyists and trade fish traders alike find that the discus' natural habitat seem particularly to have a water temperature of between 77°F (25°C) and 79°F (26°C). These waters are already low, though many of these fish will thrive in temperatures as low as 75°F (24°C) and as high as 86°F (30°C). Those who follow have demonstrated that their discus tolerate slightly cooler or warmer waters, with discus in Southern Florida certainly more susceptible to disease at temperatures lower than 82°F (28°C).

Timid Nature

Discus are comparatively fish that do not thrive in an aquarium with tropical tank mates. Tankmates which are active, boisterous fish or which have bright, glaring lights from which the discus have no retreat. You should not put discus in an aquarium with silver dollars, danios, or other highly active fish. It's also inadvisable to stock a discus aquarium too heavily with other species, as the stress that usually results from an overall a

Above: Tank-bottom cichlids are big and aggressive! ▶ Most are tropical discus hobbyists.

Below: A dwarf pink cichlid, up the tree and shades the branches in an aquarium does the fish and its art. When these photos were taken in August 1999, discus collection would receive about totally 39 cichlids 36 dwarf cichlids.

[illegible]

[illegible]

[illegible]

[illegible] the water remains devoid of sediment capacity so the pH is easily influenced by humic acids. Most white-water rivers, though not necessarily acidified by dissolved organics, causes the conductivity of electricity to be very low, as low as 10 µS/cm [illegible] on average. The pH of black-water streams is also [illegible] low, often between 4 and 5 [illegible]. This is in fact black water, such as the Rio Negro and [illegible] water streams which [illegible] usually [illegible]

The clear-water streams are given number, such as [illegible]

[illegible]

conductivity is relatively low, around 15 µS. Through the pH of clear-water streams is acceptable to fish. They are not usually headed [illegible]. The [illegible] of clear-water streams seem to be [illegible] with [illegible] [illegible] though [illegible] are found in certain clear-water rivers. Well-known clear-water rivers include the Rio Xingu and the Rio Tapajós.

Because of its rich in silt and sediment, brown-water streams are very turbid, with very little visibility. The water is not really "muddy," but looks [illegible] brown. White-water results from a mixture of the

Rio Solimões, Rio Madeira, and the Rio Branco

Understanding Discus

Seasonal Changes

The swarming, flowering and redness of the Amazon [illegible]

[illegible] and discus fall back in the lowest levels [illegible]

Some of the ponds where discus are found are [illegible] and have a very rapid drop-off [illegible] and have very rapid drop-off [illegible] [illegible] and to have very rapid drop-off [illegible] than those in flooded ponds.

[illegible] discus [illegible] Temperature, turbidity, and acidity [illegible]

[illegible] water [illegible] discus. [illegible] Amazon [illegible] water are also frequented by discus. These [illegible] times provide the ideal [illegible] generation and are also [illegible] where [illegible] other small fish [illegible] are likely to fall into the water. With their [illegible]

[illegible] and [illegible] [illegible] 1987.

Discus are [illegible] [illegible] spawned have [illegible] [illegible] [illegible] temporarily [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] breeding in [illegible] color. A [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] and down. Frightening the [illegible] into the net.

The discus [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [

Water Chemistry and Filtration

The Importance of Filtration

[illegible]

[illegible] changes in the water with filtration. We cannot expect fish to do well if we require them to live in their own waste.

Historically, fishkeepers have relied on large and frequent partial water changes to keep water quality high. As we will demonstrate [illegible]

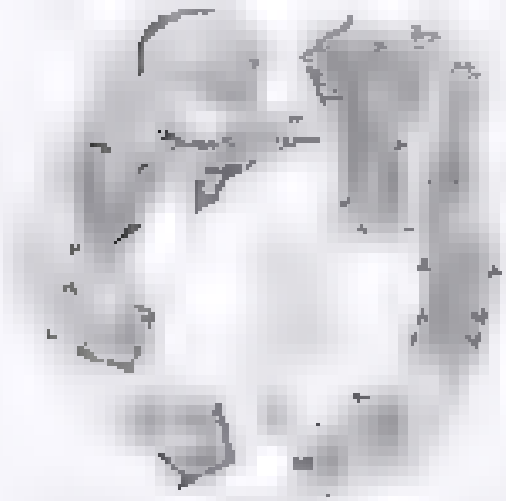
The Nitrogen Cycle

All animals produce nitrogen as a component of their metabolic waste. The form of nitrogen excreted depends on the habitat and physiology of the animal. Humans, for example, excrete most of their nitrogen as urea, a form of nitrogen. We concentrate our nitrogen wastes because we cannot afford to lose as much water as would be required to excrete ammonia (NH3). If humans excreted pure ammonia, we would daily flush vast quantities. Some desert animals, because they can afford almost no fluid loss, excrete uric acid, a form of urea. Fish, on the other hand, can afford great fluid loss, since they live in a medium of water. They directly excrete ammonia as a waste [illegible]

Water Chemistry and Filtration

In nature, the nitrogen cycle converts organic nitrogen wastes into nitrate and other nitrogen compounds that benefit plant fertilizer (nitrate). A local organism might be helpful.

Nitrification refers to the degradation of hum [illegible] by microorganisms. When nitrogen enriches [illegible], a natural bacteria *Nitrosomonas* [illegible] converts the ammonia to nitrite (NO_2). In the [illegible], nitrite [illegible] than ammonia. Fortunately, other bacteria [illegible] can convert the nitrite and ammonia to nitrate (NO_3), a relatively harmless compound that is the highest oxidized form of nitrogen. As a result, harmful wastes are converted into nutrients that benefit plants.



Natural processing of ammonia and other organic nitrogenous wastes. The nitrogen cycle uses nitrifying bacteria to convert ammonia and nitrite into harmless nitrate. Nitrate levels should be kept low by regular partial water changes.

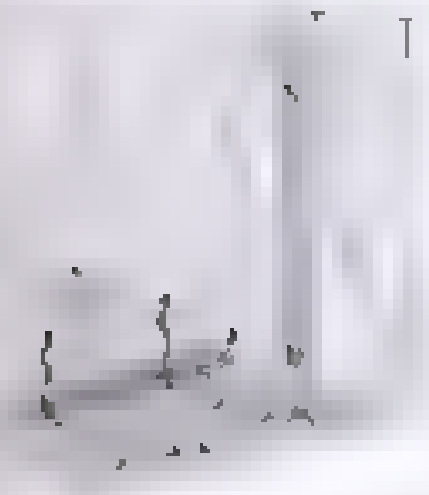
the fish [illegible] pectoral. The rich, [illegible] provide a well-oxygenated surface on which the bacteria can [illegible]. After the bacteria have had time to reproduce sufficiently, all nitrogen wastes produced by fish in your aquarium will be converted to nitrate before they reach measurable levels.

Nitrate levels above 20 mg/L (ppm) nitrate per liter will stress the fish. Certain plant nutrients such as nitrate and other minerals (especially phosphates) [illegible] aquarium must be removed by regular partial water changes.

Biological Filtration

The most important type of aquarium filtration is biological filtration. The term "biological filter" refers to the process by which aquarium bacteria and manage the nitrogen cycle in most aquariums [illegible] of biological filter is called an undergravel filter. An undergravel filter, usually made of molded plastic and perforated with numerous slots or holes, provides a base surface for an aquarium. Two to three inches (5 – 7.5 cm) of gravel substrate is placed on top of the filter completely burying the undergravel filter plate. Water is drawn up from under the undergravel filter plate by a lift tube, which displaces the water below the plate. [illegible]

Water Chemistry and Filtration



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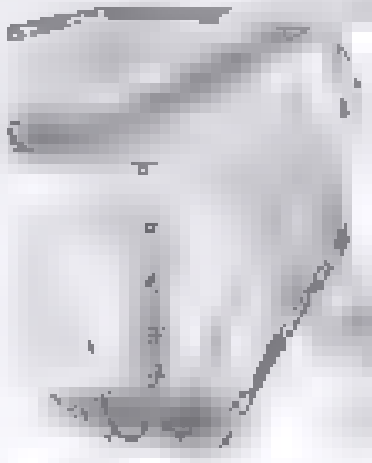


Water Chemistry and Treatment

Gravity Filters: A gravity filter is a pressure vessel containing various types of filter media. Most of filters go in the aquarium, water drains through the media and then pumped back up to the aquarium. Because it operates outside and usually below the aquarium, it can be as large as necessary and is therefore very efficient. Because gravity filters are physically as possible, we make maximum use of the filtration medium for removing the water through it.

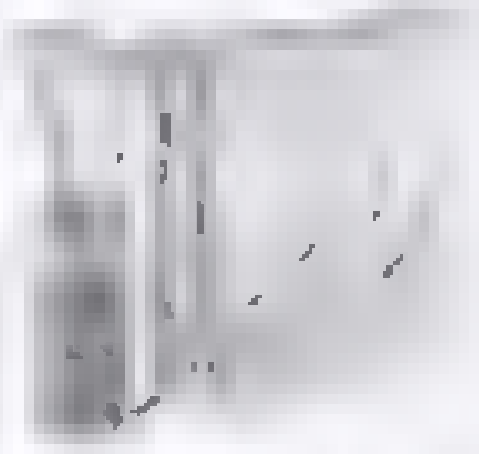
Canister Filters: are often used in conjunction with undergravel filters and are also used primarily in freshwater and marine aquariums. In situations where undergravel filters are not used, a canister

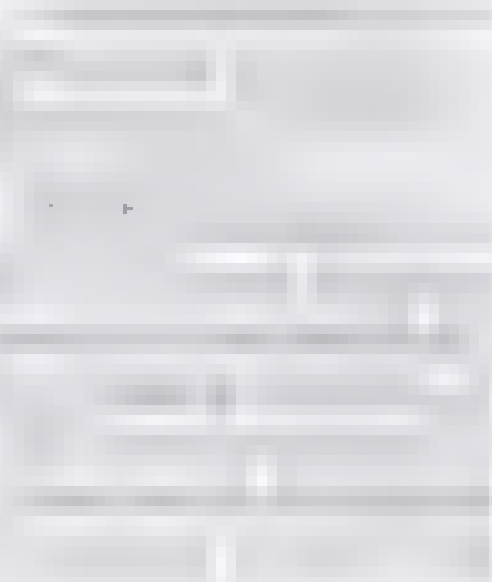
Fig. 1. Undergravel filter. The main feature of undergravel filters

Undergravel Filters: are plastic plates connected to tubes or uptake tubes. Both of these are used as blocked tubes in a canister filter, as they have high surface area and will run up dirt. If you choose a canister filter for undergravel filtration, remember several things. First, never turn the filter off or more than a half hour, as the bacteria on the filter will die if there oxygen supply is cut off, and their

and dead. Also, more or otherwise discards the biological medium. Also, consider to use to more than one tank. [illegible] of power outage in the aquarium of your tank will stop the undergravel filter. If you do not use an undergravel filter, water does not circulate through the substrate, so it can

provide toxic substances, including gas and dissolved substances such as hydrogen sulfide. Hydrogen sulfide is not





Oxygen available as they might underwater.

[illegible]

[illegible] atmosphere water by diffusion.

The carbon buffering cycle in water is a very complex process whereby organic carbon from plant and animal waste is broken down by bacteria and is assimilated by plants. A product of this process is the release of free carbon dioxide (CO_2) into the water column which forms carbonic acid. Much of CO_2 [illegible] passes out of the water and into the atmosphere and some is consumed by plants. [illegible] CO_2 also acts as a buffering agent in the bicarbonate/carbonate acid system. Basically, what this means (simplified) is that if there is not enough CO_2 in the water, the pH will rise, and if there is too much CO_2 in the water for the amount of carbonate and bicarbonate salts present, the pH may dramatically fall to 4.5 or below.

Trickle filters, because of their degassing [illegible] function as exchanger, [illegible] have large amounts of CO_2 out of aquarium water. This is great for marine aquariums or freshwater African cichlid aquariums [illegible] pH levels, and for Gulf blue tilapia, which prefer slightly acidic water, trickle filters would be detri[illegible]

Cartridge filter. Water from the aquarium is [illegible]

[illegible]

Water Chemistry and Filtration

[illegible]

overfeeding can destabilize the equation. Interestingly enough, the natural system, which is often considered a recent innovation, is how freshwater aquariums were always kept in the earliest years of the hobby, when the old books referred to the "balanced aquarium." Mild additional aeration is also necessary in a natural system, especially at night. A [illegible] natural system is described in the chapter, "The Planted Discus Aquarium."

Chemical Filtration

Biological filtration takes care of nitrogen, but not all fish waste is ammonia and nitrate. A significant portion is composed of chemicals such as phenols, dyes, and pesticides, usually in a liquid or colloidal [illegible]

Familiar yellowish coloration as well known as aquarists. Familiar. If dissolved organics reach sufficient levels, as well as by measuring the amount of bacterial [illegible]

The isolation of dissolved organics and other non-biotic contaminants from aquarium water is called chemical filtration.

Activated Carbon. The most common agent of chemical filtration is activated carbon, [illegible] ordinary charcoal [illegible]

significant process. Each individual grain of carbon has a huge surface area because of the innumerable micro-sized crevices caused by activation. It is this tremendous amount of surface area that makes [illegible]

[illegible] pesticides, and will do [illegible] conditionally, deeper. Some grades of activated carbon are less efficient [illegible]

Some brands of carbon are available in clear, [illegible] filter bag, but you [illegible] also buy bulk carbon and reusable dispensing filter bags at a pet store [illegible]

[illegible] Water should be filtered through the [illegible]

[illegible] the carbon bag should entirely fill the [illegible]

water cannot easily flow around the carbon [illegible]

molecule of ozone (O_3) has three oxygen atoms

toward making another oxygen atom in the atmosphere and go back to being stable oxygen. It is this tendency to donate an oxygen atom that makes ozone a strong oxidizer and thus a powerful agent of chemical disinfection. When ozone comes in contact with microbial organisms, it oxidizes them and also rupturing them apart. Ozone is also behind the killing bacteria and protozoans in water. Because of its powerful oxidizing capacity, ozone is often used to purify drinking water for human consumption.

The problem with ozone is that it is such a powerful oxidizer that it can cause damage to tissue structure microscopic, such as gill and skin tissue. Despite its instability, ozone does stay in solution for a long enough time to be effective and free enough

have been conducted but are not yet in the course

[illegible]

[illegible]

[illegible]

Mechanical filtration is the most important of the three types, but it is the one most people think about when they think of aquarium filtration. [illegible]

Mechanical filtration is the process intended to remove particulate matter from aquarium water. Aquariums constantly produce solid waste, because some food goes uneaten, some plant leaves remove this debris because it is unsightly, and because it will eventually break down into dissolved organic pollutants that pollute the aquarium water and spoil the water quality.

Aquarists want their aquariums to be crystal clear, but they do not care whether the water is clear [illegible] often tinted and charged with organic dyes. So we [illegible] only be present in acceptable quantities, especially in a breeding aquarium. But what aquarist would be able to [illegible] if we like fish? Thus, mechanical filtration is needed for the "aesthetics" as well as for the fish.

The most common medium for mechanical filtration is floss. Synthetic floss is used to trap particulate waste. When the floss is eventually dirty, it is removed, along with the dirt it has absorbed. The more often you replace your filter pads, the cleaner your aquarium water will be. Most aquarists are never a minute or two from their aquarium filtration. Regular maintenance will keep the aquarium. A small pump draws water up, forces it through a cartridge filter medium, and then returns the water to the aquarium. Other best filters have compartments for both filter floss and chemical media. Such filters are available in sizes for small to large aquariums, though here filters are commonly used for smaller aquariums of 30 gallons (75 L) or less. For larger aquariums, a canister filter is a better option. A canister filter can be equipped with floss for mechanical filtration, activated carbon and molecular

[illegible] of the filter to remove it. Discussed

Water Chemistry and Filtration

[illegible] the fourth-stream a combination of [illegible] biomass. This system provides [illegible] of very high [illegible] is very highly recommended. When using such an efficient filtration system, remember the need for regular partial water changes to replenish necessary trace elements.

As we discussed earlier, if you use undergravel filters it is important to keep them as free of dirt as possible. One way to accomplish this is to use either a hoy or [illegible] tube to periodically vacuum the aquarium water clear of dirt. Because most of the dirt gets [illegible] and thus, it never gets to the undergravel filter.

A Diatom Filter is a pressurized vessel in which water is forced through a paper pad. A fine white powder composed of the skeletons of tiny organisms [illegible] called "water polishing." Because of their [illegible] very small pores, a number of [illegible] Diatom filters are not intended for continuous duty. You may want to use them like [illegible] a few hours [illegible] work or so, or you might use it only when the water gets cloudy or dirty. As with any [illegible] filter, be careful to rinse and clean the filter pad [illegible] whenever you store it for an extended period.

The Carbon Cycle

Many aquarists need not concern themselves with water hardness. Yet an understanding of water hardness and the other simple processes of the carbon-bicarbonate cycle is critical for anyone who expects to keep discus successfully.

Water Hardness

Carbonate Hardness As rain falls to earth, it reacts the ground it begins to be affected by the minerals in the soil through which it passes. Type

Water Chemistry and Filtration

[illegible] through topsoil and also [illegible] decaying plant matter [illegible] As a result the rainwater becomes slightly acidic because the carbon dioxide (CO_2) reacts with the water (H_2O) to form carbonic acid (H_2CO_3). The carbonic acid, in turn, dissolves calcium carbonate ($CaCO_3$). Dissolved calcium bicarbonate ($Ca(HCO_3)_2$). The presence of calcium and magnesium carbonate in water produces what is called hardness, which is measured in German degrees or Carbonate hardness (dKH).

[illegible] back to water through the soil and rocks, it picks up many other mineral compounds, especially phosphates, [illegible] precipitation of these elements is called non-carbonate hardness which is usually measured in German degrees of Noncarbonate Hardness (dNCH).

[illegible] total hardness [illegible] be seen as carbonate and [illegible] usually used is milligrams per liter or ppm are carbonate [illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible] mg/L = [illegible] part per million (ppm)
[illegible] = [illegible] (ppm)

[illegible] carbonate hardness can be reduced by the drop [illegible] in form again and precipitate out in solid form. For this reason carbonate hardness is often called "temporary hardness," [illegible] contrasted with non-carbonate hardness, or "permanent" hardness.

Human beings take water hardness for granted, [illegible] individual [illegible] issues in aquarium fish, however, water hardness is critical, because [illegible] organisms with which the fish and especially their [illegible] are accustomed. It is important to keep fish in water that is similar to that from which they were taken, for if soft-water fish are put in very hard water they will be under constant stress and their eggs may not be fertilized successfully. Water hardness also affects the regulation of the fish's blood calcium level, so significant differences between a fish's native water hardness and its aquarium environment require the fish to work harder to maintain its [illegible]

Though cichlids are not very tolerant of the fluctuations in acidity, Malawi cichlids have proven to be remarkably adaptable to varying degrees of hardness in aquarium water, ranging in water with a general hardness of since 20°dH (356 ppm $CaCO_3$). It is only when breeding discus, that have very low-end water hardness levels (around 3–4 dH), is important, because in harder water the shells of the eggs become phenomenally resistant to penetration by [illegible]

[illegible] you can adapt your discus to hardness levels more [illegible] [illegible] are raised in slightly hard water (between 4 and 10°dH). If you purchase such fish, they probably have already been acclimated to a certain degree to higher levels of water hardness. You will

Water Chemistry and Filtration

[illegible] way to state results of conductivity tests [illegible]. It is accurate to say that the higher the conductivity, the harder the water, but conductivity measurements only generally indicate water hardness [illegible]

[illegible] simply low conductivity measurements of 10 [illegible]

[illegible] in aquarium water, so a conductivity range of between 300–675 µS is the target for a diverse aquarium. We are not if that range is appropriate [illegible]

[illegible] they are extremely [illegible]. A conductivity meter [illegible]

[illegible] which measures both conductivity and pH, [illegible]

Sub and dilutes their body fluids. For [illegible]

[illegible]

Though the recommended personal boundaries of [illegible]

[illegible] where are you will have to taken your tap water [illegible]

[illegible] more hobbyists. Be sure to follow the manufacturer's instructions and note the shelf life of the reagents and the waiting time for the reagents to

Water Chemistry and Filtration

[illegible] and general hardness of tap water and the partial water changes and evaporation top-up before it comes [illegible] and adjust as necessary.

Filtering through Peat: One time-honored way to soften tap water is by filtering it through peat. Peat, which is dried humus, acts as a cation exchanger [illegible] charged ions exchanges and replaces the calcium dissolved in the water as calcium bicarbonate [illegible] with hydrogen ions. $H_2(peat) + CaHCO_3 \rightarrow Ca(peat) + 2CO_2 + H_2O$. The bicarbonate is then transformed into carbon dioxide. Peat has a way of gently and gradually lowering the hardness of the water. Since it also adds humic acids that discolor and odor, Aquarium Fishes find no major [illegible] the use of peat to soften tap water is highly recommended. If used too long, however, peat becomes [illegible] and releases all the minerals it has absorbed. For this reason you do not want to leave peat in a canister filter for too long. Peat is best used to soften tap water to the desired level and then discarded. If the hardness of your water supply is very high, you may need only to dilute it with a [illegible]

Peat is another that [illegible] be [illegible] quickly dissolve into much. Peat from [illegible] or the [illegible] United States is [illegible] to [illegible]. It is best to purchase peat designed for softening aquarium water from an aquarium store.

There are some drawbacks to peat filtration. Peat highly discolors the water, which sometimes reduces light penetration into the aquarium. This can be a problem in a planted aquarium if the available lighting is marginal. Too much tannic acid may be [illegible] in an aquarium [illegible], because it [illegible] remove the tannin from the peat without increasing the water hardness. Also, in the planted aquarium, peat [illegible] [illegible] the [illegible] plant growth, but activated carbon will also solve this problem. Neither of these drawbacks should [illegible] [illegible] using limited amounts of peat filtration is best rather than [illegible] necessary.

It is possible to achieve many of the benefits of peat filtration without using peat. Several commercial preparations of "blackwater extract" are available that contain tap water to which soft, acidic water should be added in the proper amount after [illegible] [illegible] necessary. Further water testing is necessary for the successful breeding of [illegible]

Dilution with Rainwater: Another method of softening tap water is to dilute it with rainwater. Although this has become a problem in many places [illegible]

The use of either peat or rainwater dilution is probably sufficient for those who want to keep discus in good health in their aquarium, but if you intend to breed discus, you will probably need more sophisticated water softening methods.

Ion Exchange Devices: Ion exchange resins fall into two categories: cation exchangers and anion exchangers. Anions are negatively charged ions, and cations are positively charged ions. Ion exchange resins are usually housed in a clear acrylic cylinder through which water is forced under pressure from a pump. The resins have a limited capacity and must be either replaced or recharged when they have been exhausted.

Ordinary water-softening resins, commonly used in homes and aquariums, are unsuitable for aquarium use because they result in too many sodium ions. Therefore, if you use an ion exchange heater, be sure it is designed for use in softening aquarium water. In a typical two-column aquarium ion exchange reactor, positively charged ions (cations) such as calcium and magnesium are replaced with hydrogen or

[illegible]

[illegible] eventually blow out of solution [illegible]

[illegible] necessary. Also, while the diffusion from the ion exchange process is valued very soft, we do have to still may contain dissolved impurities and [illegible]

[illegible] Reverse Osmosis Membrane Reverse osmosis [illegible]

Reverse osmosis filter [illegible]

Water Chemistry and Pretreatment

separate tube, and can be used for a wide range of pH and temperature conditions, so it is highly flexible. The process results in water that is 94 to 99 percent pure, the percentage of the distillate.

Two types of membrane are used in reverse osmosis systems: TFC (Thin Film Composite) and CTA (cellulose triacetate). CTA membranes are very tolerant of chlorine in the source water, so you don't need to add chlorine to the source water because they are very susceptible to bacterial growth on the cellulose fibers in the membrane. For this reason, CTA membranes are not

dissolved solids higher than 500 ppm, or any water that has a pH higher than 8.5. The membranes are very tolerant of the [illegible] pH range, which allows them to handle water that is extremely hard (up to 400 ppm calcium carbonate), which would be impossible with other membranes. TFC membranes are resistant to bacteria, and they are particularly suited for removing organic phosphate and silicates. The main drawback of the membrane is its tolerance [illegible] chlorine. Because almost all municipal water supplies chlorinate the water, municipal water must first be run through an activated carbon filter before being passed over a TFC membrane.

Both membranes require a water temperature of at least 15°F (9.4°C), so you should install your RO unit in such a way that it is impossible for accidentally run hot water through the RO unit. Freezing will also destroy the membrane, so the unit should

Membranes should never be allowed to dry out, so if [illegible] anticipate not using your unit for an extended period of time, remove the membrane and store it in

other words, for every 1 gallon (3.7 L) of permeate (filtered water) and 4 gallons (15.1 L) of concentrate (contaminated water), expect to waste 19 L of water. The membrane must be flushed

regularly (at least [illegible] per week) and usually replaced in two to three years. Other [illegible] regular flushing and periodic replacement of the membrane, there is no consumable [illegible] of purchase or replacing necessary.

Normally within the [illegible] years, RO units are more [illegible] result of the [illegible] available.

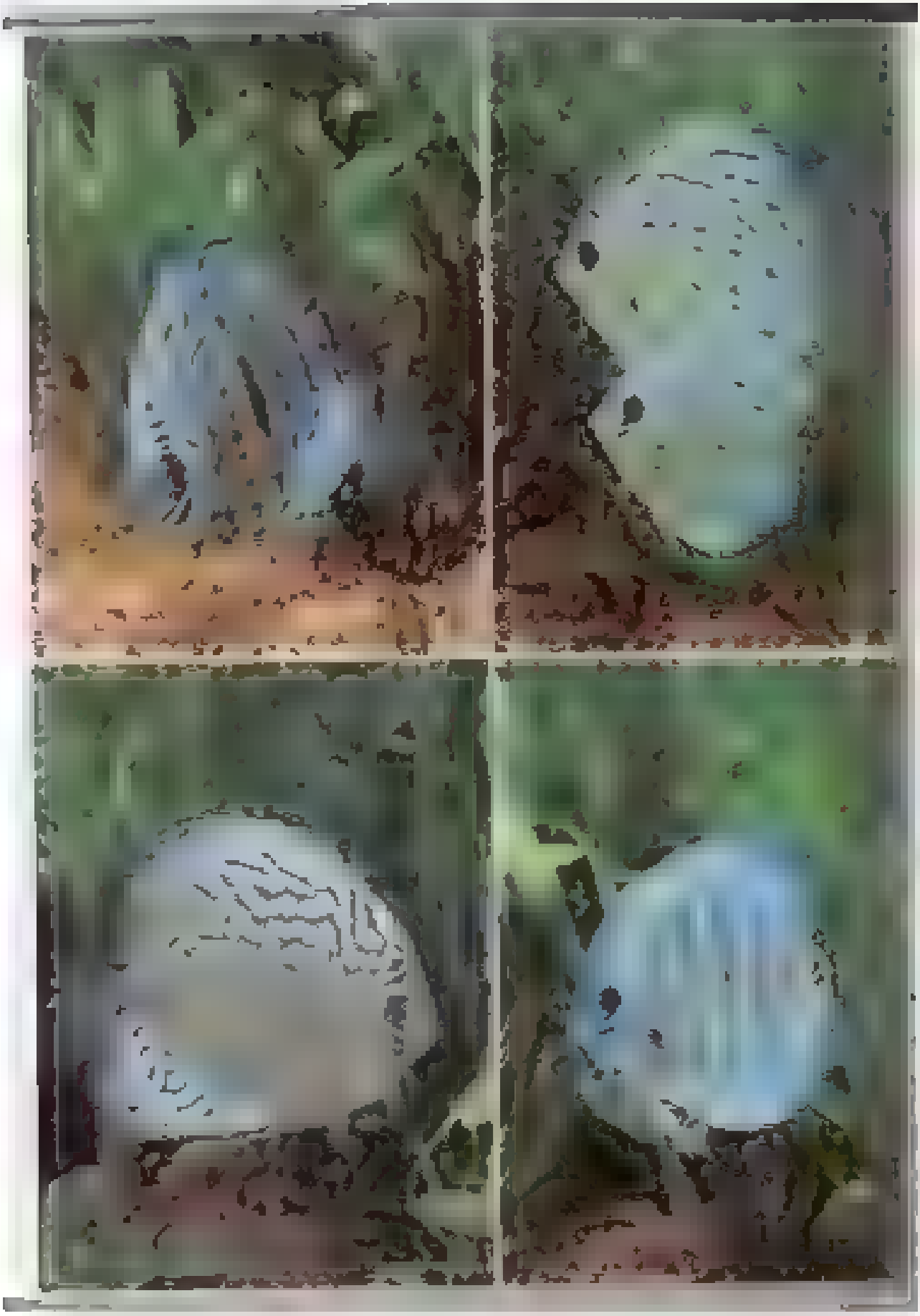
tap water to adjust the hardness and pH to the recommended levels. The only safe way to do this is to use a [illegible] distillation. Adjust the water hardness and pH

pH

The acidity or alkalinity of water is measured in units of pH, or power of hydrogen (formula H^+), on a scale from 0 to 14. A pH of 7 is neutral, with numbers lower than [illegible] acidic and numbers higher than 7 alkaline. The pH scale is logarithmic, so a pH of 4 is ten times more

quick change in pH from 6.0 to 3.5 is a significant and possibly fatal change for fish.

Many factors affect the pH of water, including the amount of dissolved carbon dioxide, but the hardness of the water is usually significant. For this reason, water hardness is used to "buffer" pH. "Buffering" is the water's ability to support the pH, and to resist pH change. If you have ever tried to



Water Chemistry and Filtration

Water Chemistry and Filtration

[illegible]

[illegible]

[illegible]

[

Getting Started

Placement of the Aquarium

Staff Development

The Aquarium and Canopy

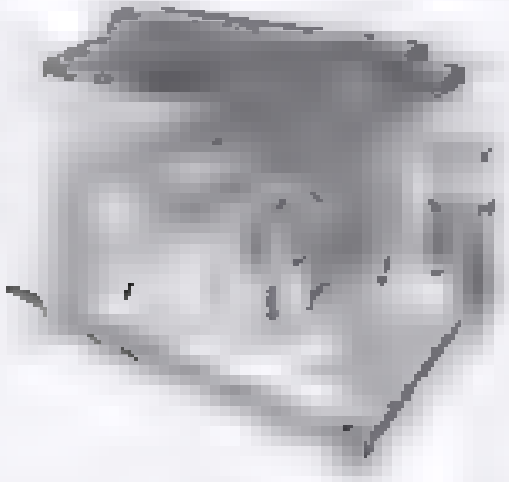
Getting Started

[illegible]

[illegible]

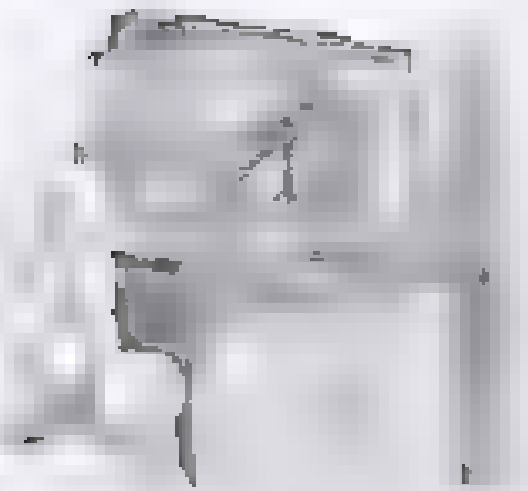
[illegible]

Getting Started



Typical Aquarium Setup

Getting Started



[illegible]

[illegible] with the discus. Also, the planted aquarium [illegible]

[illegible] plants [illegible]
The Planted Discus Aquarium

Lighting

Discus come from waters that are a mix of [illegible]

[illegible]

[illegible]

other word, refers to the individual bands of light. Visible light is composed of many different bands of light. We are concerned with those bands of light that penetrate the water, causing the growth of aquatic plants and affecting the way that natural objects look and are perceived by us.

For a breeding setup, or for a fish-only aquarium, normal lighting concerns are enough intensity and the proper spectrum to display the fishes' colorations. This can easily be achieved with one or, at the worst, two common aquarium light fixtures, as long as we carefully choose the lamps.

The light source of choice will almost always be fluorescent lamps. Fluorescent lamps are by far the [illegible] cost-effective, easily replaced, generally very little heat, and are available in a wide variety [illegible] fluorescent lamps are usually not desirable for aquarium use because of the cross-flicker [illegible] circuits, and because incandescent lamps are very [illegible]

[illegible] is a measurement of the portion of electricity consumed by a lamp that is converted to visible light. Only about 6 percent of the electricity consumed by an incandescent lamp is converted to visible light. Fluorescent lamps are very efficient, converting upwards of 60 percent of the electricity consumed into visible light. [illegible] a 30 watt fluorescent lamp burns much hotter than a [illegible]

[illegible]

will be dead.

Heating

We have already noted that discus require higher temperatures than most other tropicals. While it is true that discus can be maintained at temperatures of around 76°F (25.5°C), they thrive at 80°F–82°F (26.7°C–28°C). Any other fishes or live plants kept in a discus aquarium must also be able to do well at these elevated temperatures.

Lecture Notes

[illegible]

[illegible]

[illegible]

Getting Started

[illegible]

[illegible] rock or other materials in a way that [illegible] a solid colored background of blue, black or green. Some may choose a commercial sea or [illegible] though some [illegible] [illegible] Photographic backgrounds often draw attention to themselves and away from the fish. It [illegible] that the fish often feel insecure unless they have the security of a background. If you are designing a "room divider" aquarium that is open to view all four sides, you should provide enough cover in the center of the aquarium to satisfy the needs of your [illegible]

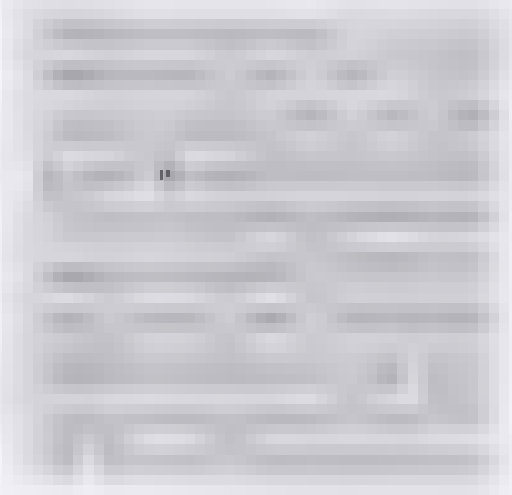
Substrate Considerations: Unlike many other cichlids, discus seldom disturb the substrate. You will probably purchase a commercial aquarium substrate. Though large-particle sand blasting gravel is just as suitable, natural in appearance, and inexpensive. Look for the darker, natural gravels because these will not reflect light. Most aquarium gravel is quartz, and is perfectly acceptable for discus. Marble looks attractive, and is suitable so long as it does not contain calcium. If you are unsure about the mineral makeup of the substrate, put a little of the gravel into a cup with some vinegar or diluted hydrochloric acid. If the vinegar fizzes, the gravel contains calcium or other pH buffering minerals that, down the road, will raise the carbonate hardness of your aquarium. Whichever substrate you purchase, buy enough to provide a minimum depth for your needs. If you are using undergravel filtration, a depth of 2 to 3 inches (5-7.5 cm) is about right, while if you are not using an undergravel filter, the danger of anaerobic conditions in the gravel becomes less to be [illegible] than 1 inch (2.5 cm) of substrate. Because most the

Substrate Arrangement: [illegible] a flat, even layer across the bottom. It is usually best to slope the gravel downward from the back to the front. Sloping the gravel adds visual interest [illegible] aquarium which is easily removed. Gravel may be [illegible] by building [illegible] with pieces of glass or plastic, which are [illegible] in the tank. [illegible] [illegible] made with rocks and wood are less stable, [illegible] [illegible] and [illegible] [illegible] silicone sealant designed for aquarium [illegible]

Many sealants purchased from hardware stores contain additives that will poison the fish and beneficial bacteria, and [illegible] silicone sealants contain [illegible] toxic to fish.

Rock and Landscaping: Rock work is not [illegible] various other cichlids. If you do use decorative rock in your discus aquarium, selection is important because many rocks for adding many used for aquarium use contain metal ores or pH buffering minerals. Marble is calcium carbonate, and is thus unsuitable for discus. Only smooth, [illegible] rocks should be used for discus. Avoid limestone and other rocks that will raise the alkalinity of your aquarium. Perform the vinegar test on any rocks of unknown mineral content [illegible] rocks to hide behind. Too many rocks will cause the [illegible] too many types and colors of rocks. Remember, [illegible] in nature, familiar types of rocks usually occur together. Therefore, it looks much more natural when [illegible] a few of only one type of rock or gravel. Smooth, dark rocks are the best [illegible] for discus cichlids.

Driftwood Considerations: Driftwood is often available from pet stores, and [illegible] of [illegible] to



"Underwater" -but that is considered pleasing by many aquarists.

Plant Conservation: Many will argue that plastic plants have no place in a "real" aquarium, but your choice between live and plastic plants depends on how involved you want to get with the aquarium. The cultivation of live aquarium plants can be an interesting aspect of the hobby, but you will have to allow the time to do this and place

Plant Aesthetics: If you choose plastic plants, pick the most natural-looking colors. These are not appropriate for a cichlid aquarium, because the cichlids tend to dig up the substrate and uproot plants. Some natural hues of brown, red, and green. Place taller plants in the background, and place shorter plants in front of the foreground. Don't arrange your plants in a "jungle" fashion, with a central row of tall plants, flanked by two groups. The aquarium will look more natural if you place varieties of similar plants together. Such an arrangement will render the most natural appearance possible.

Preparation of Tap Water

Tap water contains the necessary trace elements for fish and plant growth. We human use 100 percent

Getting Started

distilled water for distant reasons it is devoid of essential trace elements, making it impossible to maintain a stable pH.

For years, chlorine has been put in municipal water to kill bacteria. For us we must be grateful that chlorine is death to both beneficial aquarium bacteria and the fish. Fortunately, chlorine is easy to eliminate. Chlorine is a gas, and it will "gas out" of solution if we simply let the water stand overnight. Unfortunately, because many commercial preparations immediately neutralize free chlorine, this alone has not cleared fish water for fish.

organic substances to form carcinogenic trihalomethanes. For this reason most municipal water supplies are now treated with free chlorine or with chloramine, a much more inert form of chlorine for aquarium use. Chloramine is formed by combining ammonia (NH_3) with chlorine. This combination forms a very stable bond that breaks down easily with a small dose of sodium thiosulfate. Unfortunately, when the bond is broken, the ammonia is released, which is why we must also chlorine for the aquarium. Chloramine. They simply break the bond between chlorine and ammonia, and rely on the filtration devices in your aquarium to remove or adsorb the ammonia. Chloramine is toxic to fish at levels above 0.5 mg/L, but is commonly present in tap water at levels exceeding 1 mg/L. Fortunately, there are now aquarium preparations that effectively deal with chloramine. If your water supply contains chloramine, be certain that you purchase a chlorine/chloramine remover. A simple dechlorination action is the job.

After ensuring that your tap water is safe from chloramine and chlorine, adjust the hardness (if necessary) to an acceptable level. This is easy to do in an initial recipe, as you need only test your tap water and add the necessary amount of deionized water. Alternatively, you can simply fill your entire aquarium with tap water and allow the entire water volume through peat until you reach the desired level of hardness.

Initial Conditioning of the Aquarium

After the aquarium has been filled with dechlorinated water of the correct hardness, the biological conditioning of the water begins. This involves cycling a sufficient quantity of nitrifying bacteria for the fish load of the aquarium. Start the water circulation, including heating, aeration, and bacteria will multiply faster in the warmer water. Let the water circulate through the filters for about a day, giving the water time to reach the desired temperature. Also, check all air and water hoses for leaks.

The easiest way to introduce both bacteria and nitrifying products is to add a handful of fresh fish in the aquarium and let them go. The fish bring small amounts of nitrifying bacteria with them on their bodies, and as the fish excrete waste they provide nitrogen wastes for the bacteria to consume. When the fish excrete ammonia, the ammonia level of the aquarium water rises, because the ammonia is built up. Sooner than the bacteria can "survive" in feeding the water with an ammonia level, or provide this gradual buildup of ammonia. After the Nitrosomonas bacteria have built up a sufficient level will begin to rise. Again, this is because the second type of nitrifying bacteria, Nitrobacter sp., have not yet built up to levels sufficient to process

As soon as the Nitrobacter sp. have started to a sufficient level, nitrite levels will fall to nothing. When both ammonia and nitrite levels reach zero, the aquarium is said to be conditioned, or to have

For the first week after fish have been introduced, test the ammonia every other day. During the second and third weeks, test both ammonia and nitrite every other day. Remember, test kits are the only way you can see the progression of the conditioning. After

Getting Started

Why should you use the sample writing?
Aquarists may want to use a few treatments.

[illegible]

[illegible]

[illegible] which might fish are [illegible]

Health

The first step to success is obtaining healthy fish. Look for fish that are active and relaxed looking, not fast, jerky, or even somewhat intimidated by their surroundings. Across the forehead of the fish, it should be full and broad, not pinched and skinny. Thinness in the forehead is a sure indication of malnutrition or internal worms. A common allowance indicates that the fish has gone a while without food and may be loosed because reserves of the abdomen area is indicative of the fish's forehead is filled out and the fish is curious. Check to make sure the body profile is round, because many poorer-quality discus have lost their natural roundness of body. Notice whether the skin

[illegible] of the body. If the eye looks too large, the fish is stunted and will never grow into a healthy adult.

Obviously, don't buy a fish that has body lesions. The lesions are probably be treated and cured, but treatment becomes more difficult when accompanied by the mental stress of acclimation. The fish is in a better condition to clear the injury, [illegible] doesn't need to [illegible] and [illegible] the fish as you would have to do.

Discus that are dark and show their vertical bands are excited or under severe stress. You may determine whether the cause is serious. Don't consider buying a small fish with unusually bright coloration, which probably indicates that the fish has been treated with medicines. Such fish may lose their color and be sickly. Avoid fish that are obviously underfed—sunken or "hollowed" in the center. Notice whether any white strings of feces hang from the fish's vent. This is usually an indication of disease, and the fish and possibly all fish in that tank should be avoided.

Observe how active the fish feed. Note whether they aggressively attack the food, or pick at it and spurn it. Discus that pick at their food may become excellent specimens after acute acclimation has if you are paying dear cash, you should expect an excellent specimen from the start. Notice whether

Getting Started

[illegible] the fish seems to have difficulty [illegible] Some discus seem to have difficulty [illegible] [illegible] at room temperature this appears to be an inherent weakness rather than [illegible] [illegible] [illegible]

Getting Started

[illegible]

[illegible] difficult to see adults, because [illegible]

[illegible] overfilling [illegible]

[illegible]

[illegible]

[illegible]

[illegible] slide or their spines will punch holes [illegible] other and serious infection can result. The [illegible]

[illegible]

Acclimation

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] purchase wild-caught discus, it is critical that you gradually acclimate these fish to [illegible] conditions.

Quarantine

All new discus, especially wild-caught ones [illegible]

[illegible] signs of disease. In [illegible]

[illegible] If you do not provide sufficient shelter for them to hide in, hiding in the thicker and denser vegetation whether you provide for fish, the more time they will spend out in full view. [illegible] If you provide little or no shelter, the fish will cower in the corner, the only refuge they can find. Provisions for acclimation and quarantine are the [illegible]

The Planted Discus Aquarium

[illegible]

[illegible]

[illegible] the most beautiful of tropical aquarium fishes. Such aquariums — where the aquarium is literally an implanted garden of plants — in contrast to the aquarium that has one or two sword plants here and there scattered among plants. Plants. Outside aquariums are densely planted forests of red, green, and brown hues. In such aquariums it is not unusual for the plants to grow up out of the aquarium and into the top of the room, often flowering above and on the surface as an afterthought, but the fish population [illegible]

[illegible]

plants provide a high level of dissolved oxygen during the day when the fish are most active and the leaves of plants supply enough oxygen to the aquarium to keep it from going anaerobic. The high rate of uptake of minerals, plants (particularly the fast-growing species) also help control the accumulation of the water from rising. Plants remove enough nitrogen compounds from aquarium water to be considered "natural filters" and plants also provide shaded areas in the aquarium so fishes are free to move from "sunlight" to shadow. And live plants provide a habitat that at least somewhat resembles a natural one for the fish — the plants provide numerous spawning sites for discus, they will at-

[illegible] more, lower pits in dense plants. You may also [illegible] the discus in a [illegible] more "home" in a planted aquarium. Reasons for keeping discus in a planted aquarium abound, but the greatest reason may be to extend your interest in fishkeeping — whether or not an aquarium is to come to become more successful for the plants than to

The Proper Perspective

Beginners, however, [illegible] the primary purpose of the discus aquarium is the [illegible] range of these fish, and all elements of the aquarium must promote this goal. For instance, certain species of catfish are helpful for controlling algae, but if these catfishes also have a taste for the [illegible] the sides of discus, these catfishes are obviously out. Or there may be a kind of plant that you would love to have in your aquarium, but it needs colder temperatures than discus will tolerate. Lowering the water temperature for the plant could have disastrous consequences for your discus.

We will discuss some advanced techniques for keeping aquarium plants. It behooves the [illegible] however, [illegible] planted aquariums were kept using [illegible] the discus [illegible]

[illegible] can be kept without [illegible] lighting. All other devices are simply tools for [illegible] the aquarium efficiently or to achieve [illegible] goals. Lack of advanced techniques [illegible]

The Heated Planted Aquarium

[illegible]

[illegible] attractive planted aquarium.

The Substrate

Of particular importance is the substrate. Typically, aquarium substrates are small rocks and gravel [illegible] biological filters, or the substrates are kept clean as possible and vacuumed as needed and done for the health of the aquarium. For plants, the substrate is of primary importance for [illegible]

[illegible] for us to simulate the thermal conditions of the [illegible] slightly warmer than the aquarium water. This also helps circulate some water through the substrate, preventing it from going anaerobic. If you have ever seen a section of an aquarium substrate turn black, if you have seen bubbles coming up out of the gravel, and if you have ever detected that "rotten-egg" smell in an aquarium, you have seen the effects of an anaerobic reaction, in which nitrate is reduced to more harmful nitrite, and hydrogen sulfide. The gas with the "rotten-egg" smell, is produced. Hydrogen sulfide is a highly toxic compound to fish, fish tank as well as plants. If an anaerobic reaction is allowed to run unchecked, Substrate cable heating will create a continuous circulation of nutrients and oxygen between the substrate and the aquarium.

Because cable heating is low voltage even if the integrity of the cables is breached, the electrical [illegible] will not harm either your fish or you if you put your hand into the aquarium. The low voltage aspect of cable heating thus makes it even more safe than the traditional glass submersible heater, and it is impossible for the temperature to rise so high as for the fish to burn themselves against cable heating.

An electronic control maintains water temperature with an immersible temperature sensor. Cable heating requires a transformer to reduce the voltage to 24 volts, and enough heating cable to cover the entire bottom of the aquarium. But the reason cable heating is expensive—prohibitively expensive for many aquariums. Though there is no finer system than cable heating, and though you should use cable heating if you can afford it, there is a lower-cost alternative that furnishes many of the benefits of cable heating. In a fraction of the cost, it is possible to use a heat mat to achieve virtually the same effect as cable heating. Rather than [illegible] the bottom glass panel

The Planted Aquarium

glass tank, which in turn heats the substrate. Outside heating mats are not as efficient as immersed heating cables, but they do work, and for a given wattage consume more than heating cables. An effective alternative to heating mats is an electric heat pump, and an inexpensive heat source is attached to the outside of the aquarium water with a suction cup, and the overall system automatically maintains the water temperature within a fraction of a degree. Because the heat source is completely separate from the water, the substrate is always 2 to 3 degrees warmer than the water.

An advantage of heating mats is that no electrical components are in the water, thus all risk of electrical shock is eliminated. A disadvantage is that mats are less efficient and therefore consume more electricity than other heating cables or glass immersion heaters.

Substrate Fertilization

In the tropics, water plants grow in mud-rich soils, and plants are adapted to the substrates found in these soils. Some aquarists sometimes collect [illegible] or clay powder or granular form. These gravel additives are rich in iron and other fertilizers which are necessary for optimal growth of most tropical aquarium plants. The gravel additive you choose should be mixed with aquarium gravel at rates of three tablespoons per square foot of surface area. Mix the gravel additive with aquarium gravel in a bucket and then place the mixture on the bottom of the aquarium at a depth of 1 to 3 inches (2.5 to 7.5 cm). Place heating cables or a layer of washed aquarium gravel of about the same depth on top of the fertilized gravel. This layer will prevent fertilizer from diffusing into the water and will also act as an attractive barrier between the fertilizer and the fish. Fertilizer in tablet form is often packaged with the gravel additive, and these tablets should be inserted in the heating cable, keep the gravel substrate no deeper than 1.5 inches (3.8 cm), because heating mats are not as effective as heating cables at evenly heating the substrate. If you use a heating mat and make your substrate too deep, the substrate may develop anaerobic pockets which isolate the substrate and the water.

Lighting

For the planted aquarium, the proper lighting is very important for the successful healthy growth and development of most plants.

Light, especially the bands of light known as PAR (Photosynthetically Active Radiation), light drives photosynthesis. Photosynthesis is the pro-

plants can grow within a range of divergent light

Above: A heating pad of the design. Note the [illegible] profile characteristic of quality design.

[illegible]

[illegible] regarding the lighting above the aquarium. [illegible] allow your pet to move up or down in the aquarium. You will have the benefit of a new viewing angle on [illegible] and [illegible] the pet's energy [illegible] your pet. [illegible] the water's surface. Also, with an open top, feeding is simplified. The advantages and disadvantages [illegible] the aquarium and heat loss from increased evaporation. [illegible] the choice of lighting, [illegible] fluorescent lights [illegible]

HID (High Intensity Discharge) Lighting

HID lighting includes metal halide (MH) and mercury vapor (HQI) lighting. Both of these are high intensity light sources and are excellent for [illegible] much denser than the aquarium than fluorescent lighting, [illegible] depth. Some type of HID lighting may be right for you. HID light sources provide more lumens per watt than fluorescent lighting, and a typical HID lamp lasts significantly longer than a fluorescent tube. HID lighting, however, is more expensive to set up. Because of its longer effective life, however, in the long run HID lighting is less expensive than fluorescent.

[illegible] easily suspended above the aquarium for the space but we have advantages for the planted aquarium.

It should be noted that all HID lighting must be [illegible]. HID lamps were originally designed for outdoor use and the generally safe [illegible] of these HID lamps should always be enclosed in a metal fixture with a 1/8 inch [illegible] glass and tempered [illegible]. Aluminum is the preferred housing material, as it is [illegible] to rust and corrosion.

[illegible] lamp will [illegible] lumens of light upon the surface of the aquarium water. Only a large, deep aquarium requires a 250-watt light.

[illegible] phosphor coated lamp [illegible] Phosphorescent coating will correct the lamp [illegible]

[illegible] angle [illegible]

[illegible] 175-watt metal halide lamp [illegible] 15 inches (45.5 cm) above the aquarium. With either mercury vapor or metal halide lighting, your plants will flourish, and your aquarium will become a [illegible]

[illegible] from the sides of the aquarium.

[illegible]

Algae Control

When a planted aquarium is set up it has [illegible] towards algae growth. This is because of an abundance of light and nutrients [illegible]

[illegible]

Algae and other aquatic plants are competitors. They compete for light and nutrients. Certain [illegible]

[illegible]

Algae [illegible]

[illegible]

[illegible]

are attractive and do mix well with other fish. Their height in combating an algae bloom, but they will occasionally also nibble on leaves of the more delicate plants. In a heavily planted aquarium, however, this damage is usually negligible. Proponents of algae eaters claim that they are not discouraging to plants, but should not be underestimated. In many cases, they are not discouraging to plants, but should not be underestimated. Nerite snails, Siamese algae eaters, Chinese algae eaters, and dwarf gouramis are more aggressive and tolerant of it.

Algae Control through Water Quality

Most algae problems result from poor water quality. If your water is too high in nitrate or phosphate, algae will thrive. If you use tap water or demineralized water for water changes and evaporation top-up, phosphate and nitrate will not become concentrated in your aquarium. Use of molecular adsorption resins for mechanical chemical filtration also reduces phosphate. The most reliable method for aquarium plants should be nitrate or phosphate. Kits for testing phosphate and nitrate are sold in aquarium shops.

Plant Nutrition

In many water [illegible] carbonate for water hardness are found in the soil, and other less chemically stable materials (mainly iron, manganese, magnesium, and carbon) constantly wash out of the banks and into the water. Where there are other specially overlap by plants and related also [illegible] are unavailable to plants.

While tap water certainly contains many essential trace elements and other plant nutrients, these almost always occur in inorganic (mineral) forms and consequently [illegible] acid, silicon, [illegible] water. There is a [illegible] in tap water (especially phosphate) that [illegible] of algae in aquariums.

Carbon Dioxide

Carbon is an essential nutrient for plants. Plants get most of their carbon from dissolved carbon dioxide in the water. Out of carbonate, free carbon dioxide is not present in the water, plants are able to extract carbon from bicarbonate in the water. The process is called biogenic decalcification and certain plants can biogenically decalcify water enough to significantly lower the carbonate hardness of the water. It is important, therefore, to maintain sufficiently

from lowering the carbonate hardness of the water below the levels acceptable for maintenance of silicon in a planted aquarium (10–[illegible] KH). As a general rule, the higher the carbonate hardness, the more carbon dioxide required to adequately stabilize aquarium pH. Inadequate carbon dioxide levels at low carbonate hardness in a heavily planted aquarium

the [illegible] carbon dioxide levels are adequate. Test kits are available, and periodic testing for CO_2 is critical. It is possible to purchase liquid reagent tests for CO_2, one of which is

the number of possible light and nutrients. If you have provided proper [illegible] in [illegible] lighting, chances are that your aquarium will have a

In [illegible] with the CO_2 level [illegible] within a

[illegible]

healthy range without the addition of CO_2, but some will require CO_2 injection for maximum plant growth. There are both simple and sophisticated systems for dosing CO_2 into the water, and the expense for these systems parallels their level of sophistication. A very simple CO_2 injection system involves a bottle of slightly compressed CO_2, which dispenses gas from which CO_2 is sourced into a diffuser [illegible] that remains submerged below the water surface. A bubble of CO_2 is distributed in the tank

[illegible] normally from the second can into the bell

[illegible] as long as the water hardness is kept

[illegible] fluorescent lighting, such a simple system is usually sufficient.

[illegible] high-tech lighting may require more sophisticated [illegible] equipment. More sophisticated plants and having them grow and to produce epiphytes, more advanced equipment will probably be necessary.

Trace Elements

[illegible] trace elements need to be added to the aquarium regularly because they are removed from the water by plants and chemical filtration.

[illegible] Iron requirements are below the nitrogen or phosphate. Dense plant growth can significantly deplete these trace levels in the aquarium, but it is still necessary to regularly dilute the nutrient aquarium water through partial water changes. Nitrate levels should be kept [illegible] of 5 to 10 mg/L (ppm) or less. Phosphate levels should be 2 mg/L (ppm) or less. Maintaining these delicate balances [illegible] aquarium plants such as Cryptocoryne [illegible]

Iron (Fe)

[illegible] mg/L is about right for most tropical aquarium

[illegible] A suggested dosing [illegible] immersion [illegible] aquarium [illegible] but overdosing of iron is a major [illegible] of several plant diseases, which leaves iron brown [illegible] red and decay. A level of 1 mg/L has proved to be adequate for thriving growth of plants.

To maintain consistent levels of iron without overdosing, [illegible] iron-rich fertilizer must be added regularly, if not daily. This is because iron

[illegible] plants. Expensive CO_2 injection equipment is not necessary. It can be avoided if [illegible] is maintained only by keeping the [illegible]

challenging plants and having them grow and to produce epiphytes, more advanced equipment will probably be necessary.

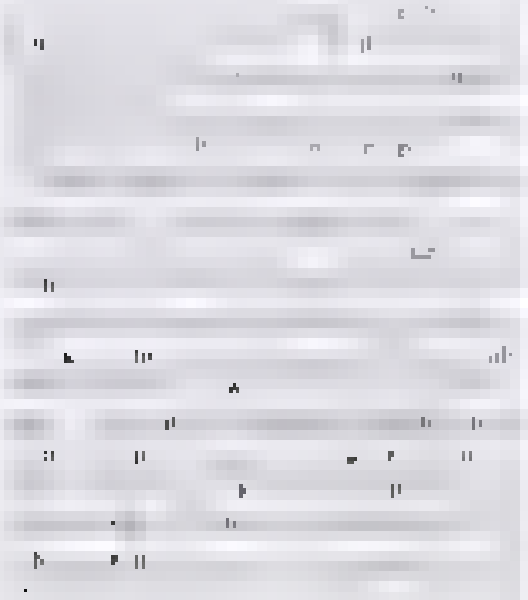
some tend at a different rate, depending on number [illegible]

must be determined by regular testing and evaluation.

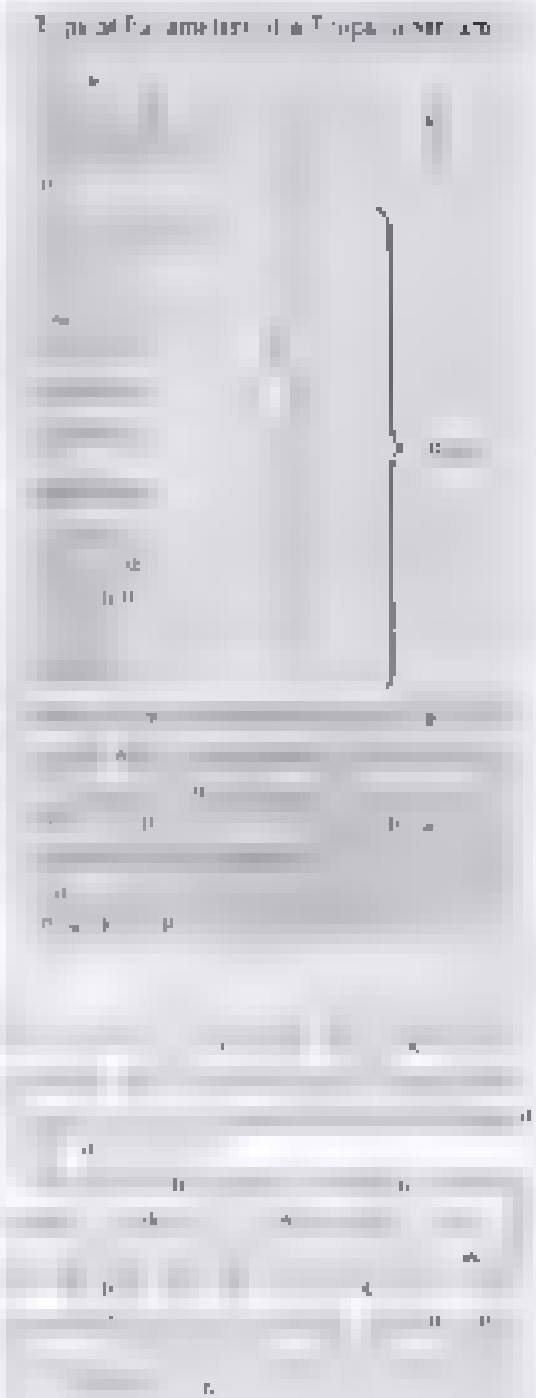
Fertilizers can be added to the aquarium by hand measure or by automatic dosing pumps. Depending on fertilizer, by hand usually sufficient, but should regularly at least of the tests a week. By dosing with fertilizer in regular, controlled amounts you ensure that you will have neither more overdoses nor deficiencies of critical nutrients for the plants. As a convenient alternative, dosing pumps make repeated or key amounts all an more easy.

Other Trace Elements and Water Changes

Though iron and carbon are the most significant nutrients for tropical water plants, they require many other nutrients that are called trace elements because they occur in minute quantities. Many trace elements are indispensable in tiny amounts, but would be toxic in larger doses. In addition, the



trace elements. By adding [illegible] from time to time or by [illegible] the partial water changes, you make sure



[illegible] the scales, gill and skin mucus of fish, so [illegible] add protective colloids to shield the fish

Suitable Plants for the Planted Discus Aquarium

Many common aquarium plants are not suitable for discus aquariums because of the higher water temperatures discus require. Feel free to experiment with other plants than those listed here, but watch them closely and remove their presence if they appear to be dying. Burning plants, or especially their roots, when in contact, can easily cause

[illegible] the cultivation of specific species.

Aquarium [illegible] are useful as nest-providing plants

can begin growing [illegible] immediately after being placed in the aquarium. All [illegible] Them

Top left: Vallisneria spiralis. Top Right: Echinodorus [illegible] Middle: Hygrophila [illegible]

[illegible] quickly at high temperatures and resume a dormant period at about 80°F (26.7°C).

Aponogeton [illegible], with its tall, [illegible] leaves, rapidly reaches a height of about 16 inches (40 cm), and is useful for planting in the rear and the sides of the aquarium. It also propagates freely; a flower stalk will develop. New plantlets will develop that will eventually root the stalk in the substrate. The aquarist may control the plantlets, or remove them for relocation. Keep under sufficient light. A [illegible] may also develop [illegible] in some [illegible].

Aponogeton [illegible] [illegible] [illegible]

well. In planted aquarium grow as long as the water is not too alkaline, since very alkaline water ties up trace elements. Most crypts also tolerate moderate light levels, so it is a good idea to stock them around taller plants that will grow to provide shade for them, particularly if HIC high-intensity lighting is used. Crypts are slow-growing and do not need much care. Because of their contrasts, Crypts can be used in the aquarium only after the other more hardy faster-growing plants have been established. Crypts can be allowed to become the main focus of the group. It will propagate readily and has very attractive leaves that sway well as a foreground plant. It only reaches a height of between 5–10 cm (2–4 in). Although the leaves are dark green on top, with a reddish underside, Crypt C. wendtii only moderate lighting. Crypts are available in a wide range—17 to 21 inches (38–50 cm)—with longer leaves and stems with undulations, so it is suitable for background planting. Unlike many crypts, C. balansae needs lots of light as plant is in the clear and allow it to shade other crypts. Crypts prefer also need weak light, and is a hardy easy species. It requires deeper rooting through nutrients, has becomes of its slender shape, plant it in a group of three or four plants. Other crypts may also need C. wendtii balansae, depending on how warm you maintain your tropical aquarium. All crypts grow relatively slowly and will not turn your aquarium into an overly jungle.

Echinodorus or "swordplants" Amazon sword are "sword plants." They are very attractive plants and are demanding of water quality. Some are marsh plants, however, they need substrate tends to spring up to serve as a rooted plant. In the case wet up plan Amazon sword that dominates in the centerpiece of the planted aquarium. Under proper conditions, the plant will grow large, sometimes it is a crowd. Because it is difficult to find space, some growing plants should be removed. E. bleheri is very tolerant of rapid water conditions. In deep green leaves make a striking display. Do not use to overwhelm, which makes the stunning sword. The plant is smaller than E. bleheri, so it is useful as a display in tanks where E. bleheri would be too large or in larger aquariums planted in lighting. The leaves are pale green. Echinodorus cordifolia is very distinctive in appearance from its previously mentioned cousins, and is sometimes called the Radiator sword. It has very large oval shaped or heart-shaped leaves and requires bright light to thrive. Placement in groups is useful because of its wide and shape, not a dramatic standing addition to the aquarium. Intense lighting is required to stimulate flowering. Aerial leaves are produced by a phenomenon called growing, and means a clay. These should be pruned at their bases to encourage compact growth of the plant. Echinodorus paniculatus, the regular plant sword, is appreciated for its tendency to form a dense carpet of greenery all over the

Crypt cordata, aka Banana Leaf. Echinodorus bleheri. Dwarf Rose. Echinodorus cordifolius

[illegible]

Hypostomus gymnorynchus is an easy catch that is [illegible]

[illegible] which are hardly inexpensive, so test kits are [illegible] rather. That is not you if these range not in [illegible] parameters are near those needed by your species. Observe well plants closely beforehand and remove them and their mates at the first sign of rot.

Common Plant Ailments

[illegible] should [illegible] damage by fish or snails. If this [illegible] your aquarium besides those we have recommended, [illegible]

Always [illegible] the aquarium so plants and animals [illegible] if they are allowed to reproduce [illegible]

[illegible]

[illegible]

Extreme deficiencies of one value the intervention to [illegible] marginal or gloser. Remedy by increasing that nutrient of [illegible] [illegible] with chemical liquid fertilizers or chelated micronutrients available from aqueous stocks increase trace elements in more frequent water changes, by increasing the percentage of tap water (as opposed to demineralized water) in the solution, or by additional broad spectrum liquid fertilizer. Highly alkaline environment lead up trace elements and micronutrient [illegible].

As causes of phosphate crystals hardening of leaves and plant death, as well as [illegible]

[illegible]

[illegible]

[

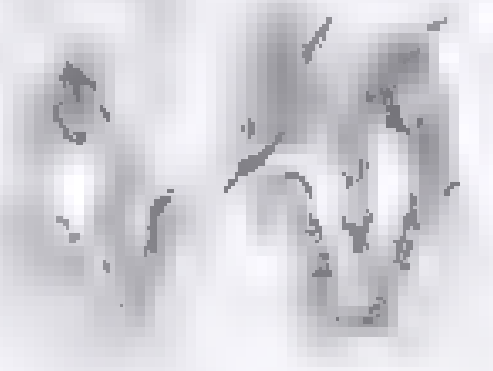
The Planted Discus Aquarium

Occasionally an outbreak of "blue-green algae" occurs and smothers aquarium plants. This so-called algae is really a cyanobacteria. It can be quickly eliminated by treating the aquarium with erythromycin at 20 mg/gal. Extract with water clarifiers for a day or two during treatment, but after treatment the cyanobacteria will be completely eliminated.

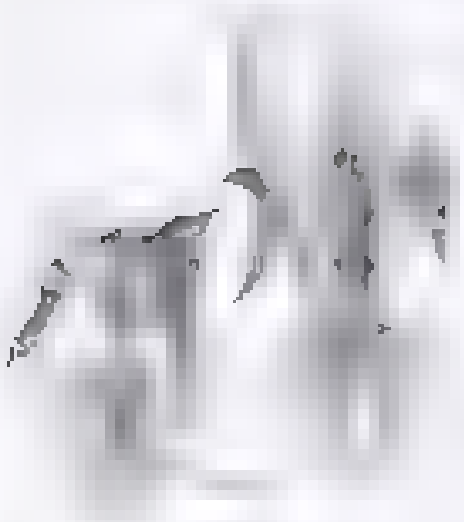
Setting up the Planted Aquarium

A successful planted aquarium begins with careful planning. A planting plan should be drawn before the aquarium is filled with water. Based on your knowledge of which plants grow larger and which remain small, which do better in the rear of the aquarium and which are better suited to the foreground, draw a plan of your aquarium, taking into account terracing, driftwood, and rockwork [illegible] would include Amazon sword, Vallisneria spiralis, Vallisneria gigantea, Dwarf plant, Cryptocoryne [illegible] with just a few of each plant. Note the example of a suggested planting for a 75-gallon (284 L) aquarium [illegible] fill level, and treat the water with a general liquid fertilizer and a water conditioner. Turn on all filters [illegible] plants [illegible]

It is often necessary to clean and [illegible] aquarium plant before planting. Leave at least 2 inches (5 cm) on the plant.



The Planted Dwarf Aquarium



[illegible]

[illegible] and are you ready for a hobby that will last the evening? Put the thermometer in an easily visible place and allow the new day arrived for setting the water temperature at [illegible]. When the water has been filtered for a few hours, remove any fragments that have broken loose. The aquarium now still be ignited in the [illegible] [illegible]. Within a week, [illegible] the [illegible] of any floating debris. Now you may want to put in a handful of decorative, which [illegible] rapidly, and is of immediate value for the [illegible] chart for consuming nutrients. Add [illegible], discovered [illegible] within or brown algae [illegible] reproductive [illegible] when [illegible] the nutrients [illegible] [illegible] [illegible]

Nutrition and Feeding

[illegible] vital, disease-resistant discus. A proper [illegible] average aquarist.

The Food of Discus in Nature

In their native waters, discus feed on insects [illegible]

These foods are especially abundant during the rainy season, which lasts from [illegible] to September. During the dry season, however, food sources are limited, and it is not uncommon for the fish to enter [illegible] in some areas such as Lake Tefé [illegible] a high-quality pro[illegible]

[illegible] tropical foods as soon as possible, because pro[illegible]

[illegible] relatively [illegible] a base fo[illegible]

[illegible]

with [illegible] liver, [illegible], [illegible] spinach, and [illegible] potato [illegible] [illegible] liver. Beef heart [illegible] also be cut and fed as small whole strips. Beef heart [illegible] [illegible] [illegible]

Nutrition and Feeding

Live brine shrimp in a small store

supplement they can be valuable. A starter culture

Feeding

During the hours that you are gone. Besides these

nutrients add up in time to an small food spike that

Provide vitamins. They are needed in minute

levels in your diet.

Disease Recognition and Treatment

[illegible] are considered critical in their susceptibility to disease. Though keeping [illegible] is not as difficult as many think, the fact remains that many aquarists have more disease problems with discus than with other common aquarium fish. Therefore, the discus keeper must surpass the average hobbyist in the skills of preventing, diagnosing, and treating diseases.

Methods for Preventing Disease

[illegible] is best to avoid disease rather than to have to cope with it. Because many diseases are difficult to diagnose, sometimes until it is too late, and some diseases are difficult or impossible to treat at all, proper disease prevention [illegible] you [illegible] and [illegible] rules.

Quarantine

All new fish, including discus and any fish needed to be kept with discus, should be in a dedicated quarantine for disinfection and observation. This is especially critical with wild-caught specimens, [illegible] the Far East. It is important that you observe new fish for signs of disease and that you treat the new fish with preventive medication even if you do not see any signs of disease.

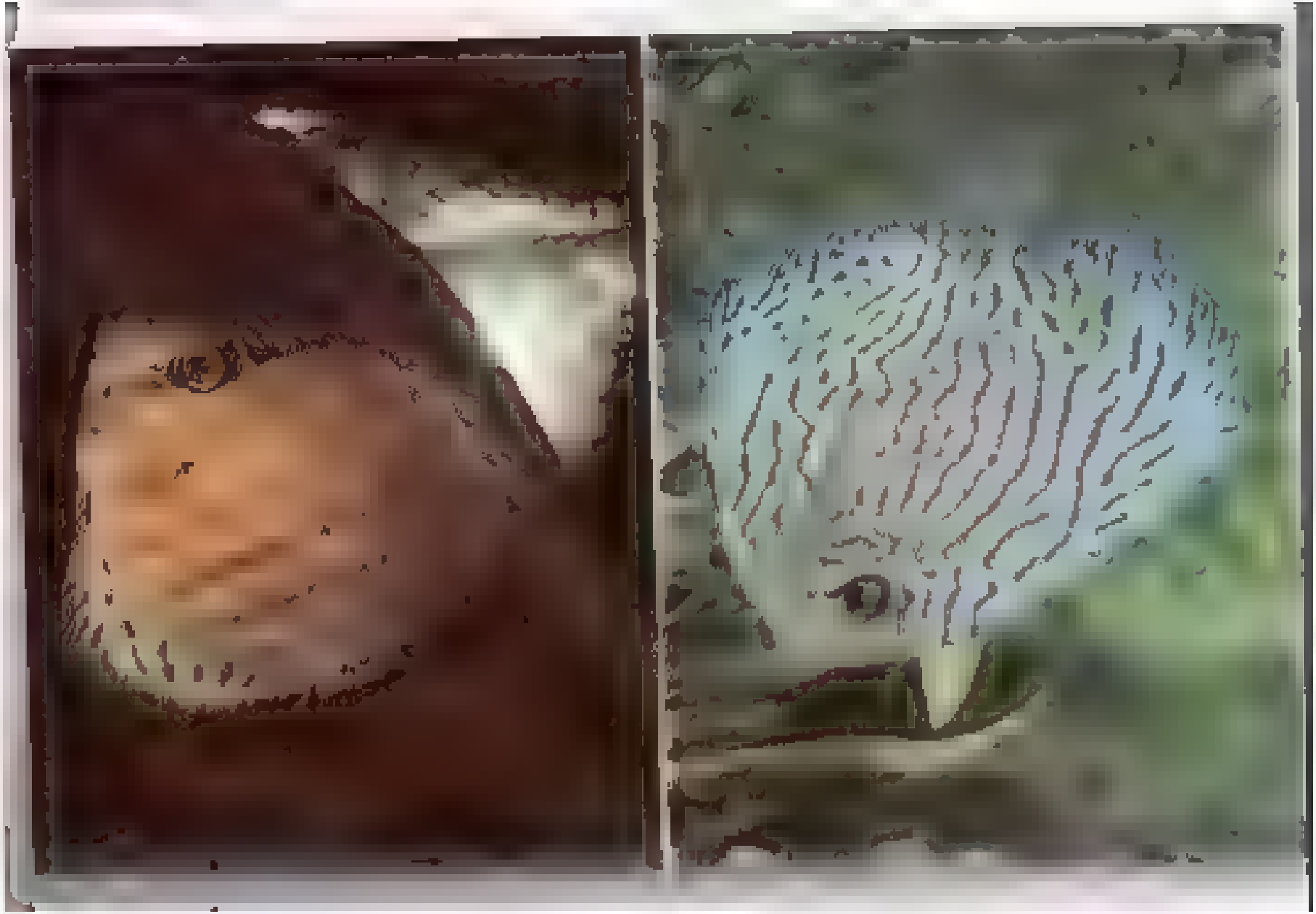
Many aquarists tend to keep other fish with discus, particularly those Amazon species that seem [illegible] problems, such as angelfish or cichlids. [illegible] just cannot or should not keep any other fish with discus, because other fish may create problems in the discus aquarium. Corydoras catfish are aquarium fish that can be kept with discus and harmless, while drawing [illegible] from small [illegible] specimens. While we do believe that discus are more susceptible to many diseases than these other fish, and that it is easier to keep discus by themselves, it is possible to [illegible] other fish with discus if you follow a careful [illegible]

[illegible] large box [illegible] duce to the main aquarium at any point [illegible]

[illegible] small fish or two to three adults. The aquarium should be [illegible] carefully, but with a large stock of [illegible] available of raw flowerpots for fish to hide in. Light should be kept minimal, as bright light does [illegible] some medications. A tight cover should be [illegible] be uncovered tank.

A sponge filter should be used for biological filtration, and a small box filter for mechanical filtration. The box filter can be left off in treating medications with the quarantine period in mind, when activated carbon can be put into it to absorb medicinal from the water. Some medications destroy [illegible] bacteria, if these medications are used temporarily remove the sponge filter, but do not place it in the main aquarium. A sponge filter [illegible] [illegible] aquarium.

Above left: A little dwarf cichlid, try keeping it in a sponge. Nicely [illegible] by [illegible] [illegible] Note that the sponge [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]



Disease Recognition and Treatment

[illegible]

[illegible]

The quarantine procedure begins with a careful search to remove any gill and body flukes that [illegible]

[illegible]

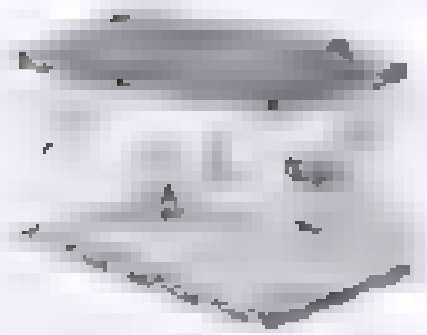
A red unpainted [illegible] with only [illegible] stage. The disease can be treated easily.
A green discus with clear white [illegible]

[illegible] Along the acclimation process. This allows the discus to adjust gradually to the pH of the quarantine tank. After about 15 minutes, lift the board and transfer the discus into the quarantine tank. The lighting in the quarantine tank should be turned off for the initial few days to allow the new discus to calm and get used to their temporary residence. Though discus are not naturally shy of light, bright lighting will add to the stress of already stressed fish. Also, during the first week, additional stressors such as Ectoparasites sp., Aeromonas sp. and Pleuromonas sp. conditions in aquarium discus, because these opportunistic may flourish the discus and cause a spike in aquarium thermometer by dissolving about the tank.

During the first [illegible] important to the first [illegible] light feeding on the second or third day. Also during the first three days the temperature of the quarantine tank should be gradually raised to 86°F

[illegible]

Disease Recognition and Treatment



(35.5°C). Warmer temperatures will accelerate the life cycle of many parasites, speeding infestations. Additionally, exposure to higher water temperatures helps eradicate two of the most common bacterial diseases, Cryptocaryon and Brooklynella. After the first eight days of quarantine (week day of week 35.5°C) temperatures, the temperature should be lowered to 86°F (30°C). Note that Cryptocaryon and Brooklynella cannot endure temperatures above 90°F

On the third, fifth, and seventh days of quarantine

consistent with feedings. Depending the feeding habits of the fish and the amount by which it is fed, Food can sometimes build for ultra large feedings or two small ones. You should repeat this procedure again and/or twice weekly to ensure that the fish are free of internal parasites.

Ammonia and nitrite levels in the quarantine tank should be tested every other day. Water changes should be performed as needed to keep ammonia levels below 0.5 mg/L and nitrite levels below 2 mg/L. By the end of the three week quarantine the fish should be free of the most common diseases

are ready to be transferred to the aquarium.

Good Water Quality

After quarantining new fish, the best thing you can do to prevent disease is maintain excellent water quality. There are fascinating water quality tests, like nitrate and phosphate tests, that are not as critical to keeping fish healthy as a stable environment. It is critical to maintain ammonia and nitrite levels at zero and nitrate below 40

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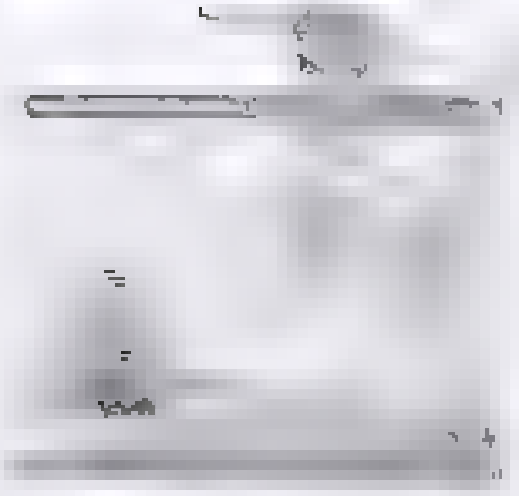

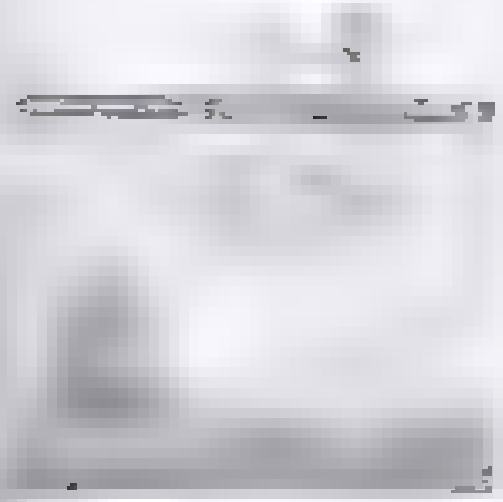

Good Nutrition

Well-fed fish are usually healthy fish, and healthy fish are usually more disease resistant than unhealthy fish. If you are careful to feed your discus

Ultraviolet Equipment

UV Sterilizers: Ultraviolet sterilizers are used to kill bacteria and some free-swimming parasites.

UV sterilizers are very effective provided they are used properly. The flow rate through the sterilizer must be within a certain range. If water flows through the sterilizer too fast, its effectiveness drastically reduced. Follow the manufacturer's recommendations for flow rate through a UV sterilizer. The UV lamp must also be changed every four to six months. The built-in UV light must be

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[illegible]

Ozone is thought to kill bacteria and is also [illegible] in the drama [illegible] tank.

Heat and UV sterilization are somewhat redundant, so there is no need to use both methods for the same aquarium. Ozone is probably superior, so stay [illegible] is a mixture of chemical filtration through [illegible] of dissolved organics, and because it also [illegible] the dissolved oxygen content of the water. [illegible] UV sterilizers. The ultraviolet [illegible] should consider using [illegible] the [illegible] but [illegible]

We should also [illegible] that diatom filters are able to filter many of the larger free-swimming [illegible] considered a mechanical aid in combating some parasitic problems.

The Discus Keeper's Medicine Chest

Here are the medications you should keep on hand at all times and in sufficient quantities for those disease problems that typically plague discus. Note that several of these medications are available only from a veterinarian, so you may find them a little hard to get. Most vets are happy to [illegible] and are [illegible] to supply you with these medications when you explain your need. [illegible] you don't want to [illegible] trouble of getting medications from a vet, there is

[illegible] to 40 percent solution of formaldehyde gas in water) and malachite green is a dye. They can be used separately, but a mixed solution of formalin and malachite green has a synergistic effect which is [illegible]

green, but malachite green is a carcinogen. It has been shown to cause the same tumors in fish at 5 ppm that formalin has at 100 ppm. Malachite green also stains the silicone in aquarium glass and mela-

[illegible]

[illegible] Dye, either formalin alone or the [illegible]

[illegible] Formalin should never be dosed into an aquarium if the water is [illegible]

[illegible] Formalin bath [illegible] never [illegible]

[illegible] bacteriostatic and [illegible] [illegible] of fresh drugs [illegible]

[illegible] dyline above the lethal dosage for fish [illegible] dyline is also [illegible]

[illegible] skin, [illegible] commercial [illegible] Praziquantel is used in a [illegible] [illegible] 5–25 mg/gallon (1.5 L). It can also be [illegible] at 20–100 mg/kg (2.2 lbs) of fish weight for [illegible] (Cavallorum). Praziquantel is very safe to use; uninfected fish display [illegible] [illegible] regular [illegible] Both [illegible] disappear when returned to uninfected water. [illegible] and should not be exposed to it.

Praziquantel is ineffective against flat [illegible] [illegible] and [illegible] worms, for which dylin is [illegible]

[illegible] with a functional biological filter, so [illegible] bath or in food. Public aquarium [illegible] praziquantel [illegible] both for both freshwater and marine fish.

Metronidazole: Metronidazole is available as [illegible]

[illegible]

Metronidazole is administered at 250–500 mg/kg (110–225 lb) every other day for three treatments, with 50 percent water changes in between [illegible]

[illegible]

The medication is absorbed through the gills and works systemically. As the fish improves, a final medicated water treatment reduces microbial load; a gram per 4 ounces of tank should be given. The night before medication, skip feeding; stay present a bacterial bloom, so water changes every several days are

[illegible]

[illegible] of health, or if the fish has stopped feeding. "Salt" water changes dilute the fish's internal

[illegible] for weighing fish. For most [illegible] the given dosage should be multiplied by 10 before testing a 10 percent diluted solution. One [illegible] medicated feeding for two small days are sufficient to rid the fish of parasites, but the fish should be monitored for another three weeks. Other fish

[illegible]

[illegible] is not [illegible]

Cetacaine: Used by divers under the tank [illegible]. Topical cetacaine is extraordinarily effective [illegible] bacterial infection [illegible] wounds that are the main concern are often [illegible] to wear down several days after [illegible]

[illegible] usually used as an injection into the spinal muscle [illegible] the dorsal fin. The dosage is one injection

[illegible] milligrams per kilogram [illegible] of body weight. Injecting medication into a [illegible] fish might seem an unnecessary effort, but if an injection can save an [illegible] discus fish's life, the [illegible] section a small price to pay. [illegible] is a relative newcomer to the aquarium [illegible] but its effectiveness is taken on the [illegible] to those of us who have lost some beloved specimens. Fish die in less a few days from bacterial [illegible]. Cetacaine is very expensive, so it usually is [illegible] in a bath. Also, because cetacaine [illegible] rapidly after reconstitution, the unused

[illegible] permanganate is an oxidizer and will be used up by organics in the container before the

Dipping through serrated cut fins.

Dissolve [illegible] in [illegible] water at 70 degrees F. Every other day for seven days treat the aquarium with a 75 percent water change between dosages. The level of medication in the aquarium will build up over the course of the treatment despite the water changes. Metronidazole may also be added to food at a more aggressive .05 milligrams per food treatment for the eight days. If you find that metronidazole is ineffective against a particular external problem, try a preparation of furazolium according to the manufacturer's recommendations.

Bath Dip: [illegible] is a fast and effective way to relieve stress in and treat localized infections. Add [illegible] ounces of the medication to a quart of water and weigh the fish or estimate it closely. Another [illegible] is potassium permanganate but because fish are much more easily harmed by this drug, it is not as recommended.

Recognition and Treatment of Common Disease Ailments: Bacterial Problems

Fin and Tail Rot

Recognition: "Fin rot" describes a slightly [illegible] infection of the fins and tail by a number of bacterial agents including *Pseudomonas*, *Aeromonas* and *Vibrio*. These are rod shaped, gram negative bacteria that usually infect tissues that have been damaged by poor water quality, injury, or as a secondary condition from a severe systemic condition. The edges of the fins become cloudy and then white and begin to fray. The fins then become reddish and inflamed, and the fish will usually succumb if untreated. With disease, fin rot usually occurs as a result of rough handling or wild-caught specimens, or because of poor water quality. The fins are very bad. Avoid the usage of these harsh compounds. Fish may be dropped and dipped in the bath for a period of usually five to ten minutes. Concentrated antibiotic bath continuing up to ten times the normal dosage—up to 500 milligrams [illegible]. If the medication does not cause improvement in first dose, use a tetracycline, kanamycin, sulfonamide, or another broad spectrum antibiotic.

Disease Recognition and Treatment

Bacterial Lesions

Recognition: Infected lesions often appear as [illegible] These are usually caused by [illegible] or other bacteria. The lesions appear [illegible] as a whitish patch [illegible] with ragged edges, but quickly become reddish and inflamed. Characteristic the lesion becomes a [illegible] ulcer, which is [illegible] by a [illegible]

Treatment: Some bacterial infections that have not progressed past the initial stage may be treated by individual spot [illegible] Severe cases should be treated by injection with [illegible] [illegible] a [illegible] dose of [illegible] [illegible] water.

Fungal Problems

Recognition: Aquarists who have never seen fungus often wonder what it looks like. [illegible] mistake the whitish patches of [illegible] bacterial or protozoan infection for fungus. In [illegible] fungus usually [illegible] as a [illegible] visible colony [illegible] External fungus grows first on dead matter, uneaten food, and dead fish eggs. Fungus is therefore a secondary condition of already diseased tissue. Fungal spores are present in aquarium water and multiply on uneaten food and decomposed debris, [illegible] well-filtered aquarium will [illegible] managed aquarium.

Treatment: Fungus must be treated quickly because when the thread-like hyphae show against the skin, the fungal filaments are ready to attack the underlying organs. Mild cases can be treated with salt: NaCl, one tablespoon [illegible] [illegible] fish

Protozoan Ailments

Hexamita

[illegible] of disease are proper quarantine treatment for all new fish [illegible] the [illegible] Hexamita are unicellular flagellated protozoa that attack the lower intestine. Hexamita infestations are often confused with a syndrome known as "Hole and Lateral Line Disease" (HLLD), which is caused by environmental conditions (see page 34). When infected by Hexamita, the fish's flashes in the corner head down, become thinned at the head above the eyes, [illegible] in color, swim backwards, and [illegible] stools white feces. The stools, [illegible] are the first symptoms of Hexamita, even while the fish are still eating and behaving normally. Even [illegible] disease, anorexia, and [illegible] cadaver could be carrying Hexamita, and should be given a prophylactic treatment immediately upon being added to

[illegible] of the solution daily for five days. After each treatment, allow the fish a few minutes to swallow the solution, and then [illegible] the fish back in the tank. It is normal for the fish to expel some of the [illegible] back into the aquarium. Since this [illegible] causes internal damage, the fish may not begin eating or [illegible] for [illegible] after discontinuation of treatment.

Disease Recognition and Treatment

[illegible]

Symptoms: [illegible] similar to Ich [illegible] and it produces similar symptoms. For all practical purposes, the aquarist may consider [illegible] as the same condition.

"Blue Slime" Diseases (Costia, Chilodonella, etc.

Recognition: Costia and Chilodonella are particularly related to small fish. Weak or ill fish [illegible]

Treatment: Formalin at a dosage of [illegible] gallon treatments is a fairly safe [illegible]. Remember to add aeration whenever using formalin. Commercially prepared products containing [illegible] are also available.

[illegible]

Recognition: Livebearing body flukes [illegible] infestations are [illegible]. They reproduce [illegible] within a body [illegible]

Symptoms: [illegible] scratching, but with the absence of white dots typical of ich. In [illegible] and fins, and fins may fray or split.

Treatment: Prazquantel is the drug of choice [illegible] fish. It is most effective when [illegible] dylar [illegible] sufficient to remove adult flukes from a fish, though some strains of body flukes are resistant to dylar. Retreatment in [illegible] days and [illegible] will eliminate any flukes that might have been present in the quarantine.

[illegible]

[illegible] body [illegible] of gill [illegible]. Dosing with gill flukes [illegible] and [illegible] chemicals [illegible]

[illegible]

[illegible]

[illegible]

[illegible] the dorsal fin and then the rest of the [illegible]. The Cichlid brooders are [illegible] and [illegible] color. Once the [illegible] fulgens will [illegible] and feed. The [illegible] spawns [illegible] eggs in a fish's [illegible] are [illegible] by other fish. The eggs will not hatch outside of a fish. [illegible] aquarium [illegible] a long way toward

Diseases, Recognition, and Treatment

Introduction

treated in 48 days to achieve total eradication. Praziquantel dusolve is a food fish also feeds used

Environmental Syndromes ("Hole in the Head")

Recognition: A recurrent gross anatomic and histopathologic lesion has been the accumulation of "hole" in the head disease with Hexamita. This disease known seeing both conditions simultaneously in the same fish and is common among the local and Flagellates species. These, however, have been the opportunistic flagellates that are normally present in the aquarium and the frequent discovery means Hexamita has never been found in cause "hole in the head" disease a condition that could have been called "lateral and cavernous line erosion" (LLE) syndrome or psychosis. Fish with connected pits on the head

known along the lateral line. Accompanying the fish may through the syndrome in some cases erosion appearing like a corpse while swimming although in all instances, secondary bacterial infections in the lateral lesions lead to death. HLLE is a disorder found in marine tanks, mostly in large and urgent fishes (especially Pseudomonas, Aeromonas and Flavobacterium).

Treatment: HLLE is currently attributed to a lack of vitamin C, D, calcium and phosphorus. This deficiency is assumed to be a result of poor choice or variety in food, lack of partial water changes, or contamination with the local water source or activated carbon. HLLE has been reversed by one or more of the following measures: increasing the frequency of partial water changes, adding vitamin-enriched foods, increasing the amount of fiber food in the fish's diet (because fiber food is vitamin enriched - added greens and food sources, either fresh leaves or ground up in a frozen preparation), decreasing the amount of beef heart in the fish's diet (because beef heart lacks many essential vitamins).

Because the most common HLLE rarely occurs in planted aquariums, probable because fish gain nutritional benefit from edible aquatic plants, which have sources of vitamin C and other vital components.

Euthanasia

There are some cases where a fish does not respond to treatment, or a fish has acquired an irreversible illness, or a fish has severely damaged or wounded that its death is inevitable. In such cases the fish can be placed in a sealed plastic pouch containing enough water for it to breathe for a few hours, and this container placed in a freezer, where the fish metabolism slowly slows down and stops. The humaneness of this method is questionable by the

upright and remain suspended position. Alternatively, the fish can be given the anesthetic MS-222 or clove oil. In a small beaker

Breeding Discus

In the early days of discus keeping aquarists discovered that the life cycle of discus was somewhat

When the discus eggs hatched, however, the fry refused to eat anything presented to them, and they quickly succumbed. This was in marked contrast

are highly to feed adult discus healthy enough to spawn and to raise the fry to maturity. While the casual breeder may not be particularly interested in developing a strain of discus, all discus breeders

aspiring professional breeder. The subject of discus

are from specialty societies and publications. See the appendix for bibliography and useful addresses.

Recognizing and Creating Mated Pairs

All of the discus species and varieties will hybridize among themselves in captivity, so it is

unusual for "agressive" fish can purchase already mated pairs, though they may not spawn after having been moved to your aquarium. Transport and changes of scenery may alter the relationship and they may even become extremely aggressive toward one another. If you do choose to purchase a mated pair, buy from someone you can trust, but

while if the pair does not spawn.

You can also buy a number of adult discus and

let "nature" to make the pairs. The best way, therefore, is to purchase a number of small, young and cross them to produce

It is a good idea to acquire your discus from more than one source or from different strains

Breeding Discus

[illegible]

[illegible]

[illegible]

Breeding Discus

Hatching

Rearing Young Discus

There are two methods of raising the young discus: the natural method and the "artificial" method. Most breeders prefer to allow the fish parents

Breeding Dreams

Genetically engineered animals for sale.

[illegible] should be [illegible] in the finishing [illegible] while the fly are there, [illegible] should be [illegible] [illegible] [illegible]

Index

Entry pages are indexed in **bold**.

[illegible]

Index

[illegible]

Useful Literature and Addresses

Books

[illegible]

Addresses

[illegible]

An expert answers all your questions about discus fish: feeding, behavior, health, breeding, and much more. Up-to-date and informative, yet clear enough for young pet owners. Dozens of vivid color photos and accurate drawings.